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DECEMBER 26, 1911.

POWER

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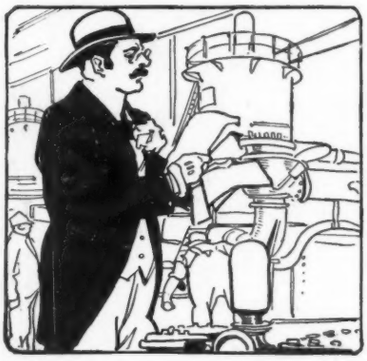
Outline of Topics 62

Contents 961. Advertising Index 53



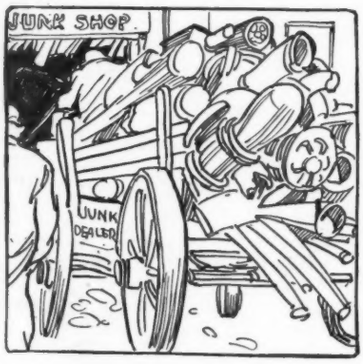
Worthington

By A. SHORTFELLOW

(With apologies to H. W. Longfellow)

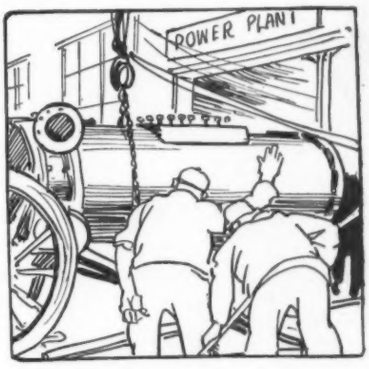
The price of coal was climbing fast,
When through a power plant there passed
An engineer of skill and fame,
Who had a knowledge of the name —
Worthington.

"Your pumps are eating up the steam.
Your vacuum's low. Your engines scream.
If you would have your plant the best,
Get goods that stand the highest test —
Worthington."



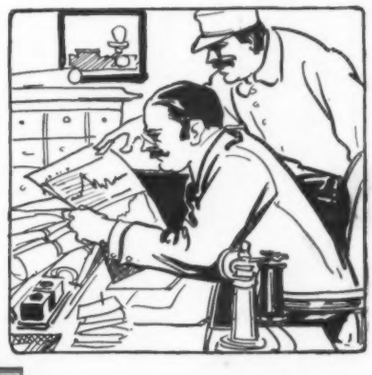
To make a longer story short,
They scrapped the pumps for such a sort
As give the most of water's flow
For steam consumed each hour or so —
Worthington.

Condensers too were taken out,
To be replaced with those about
Which none can find the slightest blame,
Again the kind that bear the name —
Worthington.



The records, never accurate,
Of water used from date to date,
Are now as perfect as can be,
The meters being as you'll see —
Worthington.

But best of all the cost is low
For fuel, though the load charts show
A greater output day and night.
And why? The plant equipments' right —
Worthington.

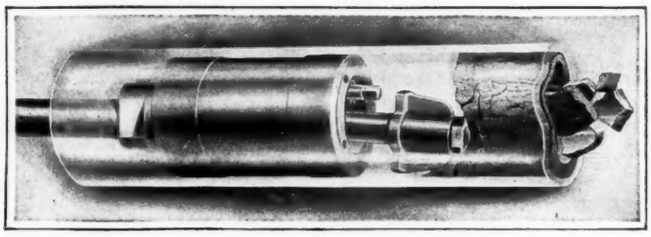


Write for Bulletin Set W-36 covering Worthington Reciprocating and Centrifugal Pumps, Condensers and Meters.

HENRY R. WORTHINGTON

WORKS: HARRISON, N. J. New York Office: 115 Broadway

W161.C



The Dean Removing Scale from the Tube of a Water Tube Boiler

Almost Any Tube Cleaner Will Remove Some Scale But The Dean Boiler Tube Cleaner Will Remove All Of It

And just that difference means a tremendous difference in steaming capacity, in wear and tear, in the annual coal bills.

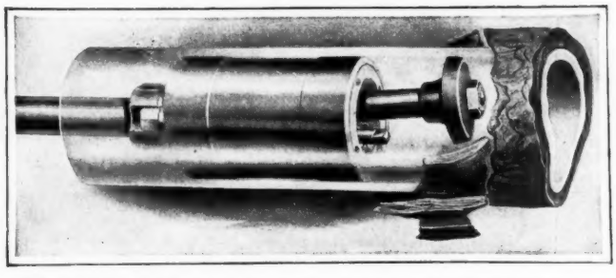
The Dean will pay for itself out of the saving it will make for you.

Put your boiler cleaning up to the Dean and you'll be surprised at the amount of scale in your boilers.

You may have scale and don't know it; you may be using scale fighters that are inefficient and don't know it.

The Dean will set you right.

Why not get one on trial and see what it will do for you ?



The Dean Removing Scale from the Tube of a Return Tubular Boiler

Free Trial Offer

We'll loan you a Dean for free trial in one boiler. We won't hurry you with the test, force the cleaner on you, nor get sore if we don't effect a sale. We simply want you to see what a money-saving proposition we have. Then it's up to you to decide what to do with it.

The Wm. B. Pierce Co.

Chicago Office:
801 Steinway Building

Jewett Bldg., Buffalo, N. Y.

An Announcement For Engineers

Interested In Lubrication

KEYSTONE GREASE

We have recently begun the publication of a free monthly bulletin that is aimed to help the engineer to a clearer appreciation of just what Keystone Grease is and will do, and that will, at the same time, contain matter about lubrication of general interest. Its title is—

The Keystone Bulletin

Our reasons for getting out the Keystone Bulletin and seeking to put it into your hands are these:—

In our thirty years' experience in manufacturing and marketing Keystone Grease, we have learned lots of things about lubrication that we know will be of interest and value to you.

Not only have we learned these things in the *past*, but we are learning *new* things right along, new methods of lubricating different parts, better uses of different grades of lubricants for different parts, improved devices for applying the lubricant, etc.

We are steadily making new tests, compiling new tables of data, gathering information that is useful, practical, that is bound to help you to better lubricating results.

You're sure to find The Keystone Bulletin worth while.

To Receive A Copy Of The Keystone Bulletin Each Month

All that you need do is to fill out and return the attached coupon. We'll send you the current Bulletin, also back numbers covering the past 6 months, with our special loose leaf binder for both these issues and issues to come.

Remember:—This offer is not meant for users of Keystone Grease alone but for every engineer interested in lubrication—in other words you.

KEYSTONE LUBRICATING CO.

Executive Offices and Works

21st, Clearfield and Lippincott Streets Philadelphia, Pa.

Branch offices and warehouses in the principal cities of the United States.
Agencies in the principal countries throughout the world.

NO CONNECTION WITH THE OIL TRUST

This Coupon Brings The Keystone Bulletin

Fill out and return it—Today

The Keystone Lubricating Company

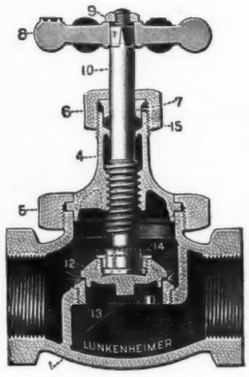
Send me Keystone Bulletins for 1911, **also other issues as they appear.**

Name.....Address.....

Firm Name.....Address.....

12-26-11

LUNKENHEIMER "RENEWO" VALVE



WHAT THE "RENEWO" IS

A valve that remains tight longer than any other. Should it ever leak, it can be repaired without any expense other than a slight amount of labor necessary to renew the seating surfaces. If any part (no matter what) is damaged or worn, it can be RENEWED with little labor or expense. This must be conceded by anyone having had even the Slightest experience in the use of valves as the attainment of VALVE PERFECTION, or as nearly so as is possible.

Why the "RENEWO" is Properly Called "VALVE PERFECTION"

BECAUSE it is so designed that it is practically indestructible. BECAUSE only the highest grade of bronze and nickel composition is used, insuring its durability. BECAUSE it is made by skilled mechanics in the most up to date valve factory in the world. BECAUSE the rigid inspection system controlling every item of its manufacture from the receipt of the raw materials up to the very minute the finished valve leaves the factory, insures as perfect a product as any human agency can develop. And BECAUSE it is made by THE LUNKENHEIMER COMPANY, and is the result of half a century's experience in valve design and manufacture.

IMPORTANT DETAILS OF CONSTRUCTION

PRESERVATION OF SEATING SURFACES—The greatest wear on the seating surfaces of a valve, caused by the tremendous velocity of the steam, takes place when the valve is nearly closed. To reduce this wear the disc in the "Renewo" valve is provided with a projecting lip on the bottom, which enters the seat ring at the proper time, and permits only a very fine spray to flow between the seating surfaces. This spray thoroughly cleanses these parts, removing any dirt or grit that may have lodged on them, thereby preventing them from becoming marred when the valve is tightly closed.

SEATING SURFACES REGRINDABLE—Should the seating surfaces become worn, they can be quickly and easily renewed, repeatedly, without purchasing new parts or necessitating the removal of the valve from the connecting pipes.

ALL PARTS RENEWABLE—This refers to every part of the valve, making the "Renewo" practically indestructible, and presenting a valve that will last as long as its connecting pipe.

MATERIAL—The Lunkenheimer "Renewo" valve is much heavier than any competing article, which means more metal, and consequently greater strength, and it will safely withstand the pressure for which it is guaranteed. The high-grade bronze used contain a high percentage of copper and tin and it is made to our own formula, the composition varying according to the location in the valve and the duty of the various parts.

The renewable seat ring is made of a hard, close grained nickel composition, the very best material obtainable for this purpose.

WORKMANSHIP—The elegant and finished appearance of the "Renewo" valve shows at a glance the very highest type of workmanship. Only skilled mechanics are employed, and, aided by machinery of special design, the accurate and rapid production of the valve is insured.

VARIOUS PATTERNS AND SIZES—The "Renewo" is made in two weights, known as the medium and extra heavy patterns. The medium pattern is guaranteed for working pressures up to 200 pounds per square inch, and the extra heavy pattern for 300 pounds. Every valve is tested under conditions more severe than occur in practice at these pressures and therefore we can safely guarantee its use. The valve is made in sizes ranging from ¼ to 3 inches inclusive.

"MOST supply houses sell them—yours Can—if they DONT or WONT—tell US"

THE LUNKENHEIMER COMPANY

Largest Manufacturers of High-Grade Engineering Specialties in the World

GENERAL OFFICES AND WORKS,

CINCINNATI, OHIO, U. S. A.

NEW YORK	CHICAGO	BOSTON	LONDON, S. E.
64-68 Fulton St.	186 N. Dearborn St.	138 High St.	35 Great Dover St.

169E

"How"
No. 2

How To Prevent Internal Corrosion

¶ Internal corrosion is a common enough boiler evil—yet one that if not properly taken care of—

¶ Will lead the unhappy engineer into all kinds of difficulties.

¶ Because internal corrosion, eating into the metal, causes leaks and final destruction of the boiler tubes and sheets.

¶ And this destruction takes place all the sooner if you try to clean the tubes with cleaners that hammer and jar the tubes to pieces.

¶ Yet corrosion can easily be prevented by proper treatment of the feed water.

¶ By using treatment such as prescribed by the Dearborn Laboratory, containing the proper reagents for the corrosive salts in the water.

¶ This is the logical way, in fact it is the only way, to tackle corrosion successfully.

¶ You send us a gallon of your feed water—our laboratory analyzes it—and prescribes such treatment as expert knowledge has shown to be the proper thing for this particular water.

¶ Then when you use the prescribed treatment you are sure of getting the right results.

¶ Suppose you send us a gallon of your feed water—today—and let our laboratory analyze it.

¶ Then we'll let you know exactly how much Dearborn Treatment, made to fit *your* needs, will cost.

Dearborn Drug & Chemical Works

Robert F. Carr, Pres.

General Offices, Laboratory and Works, Chicago
General Eastern Offices, 299 Broadway, New York

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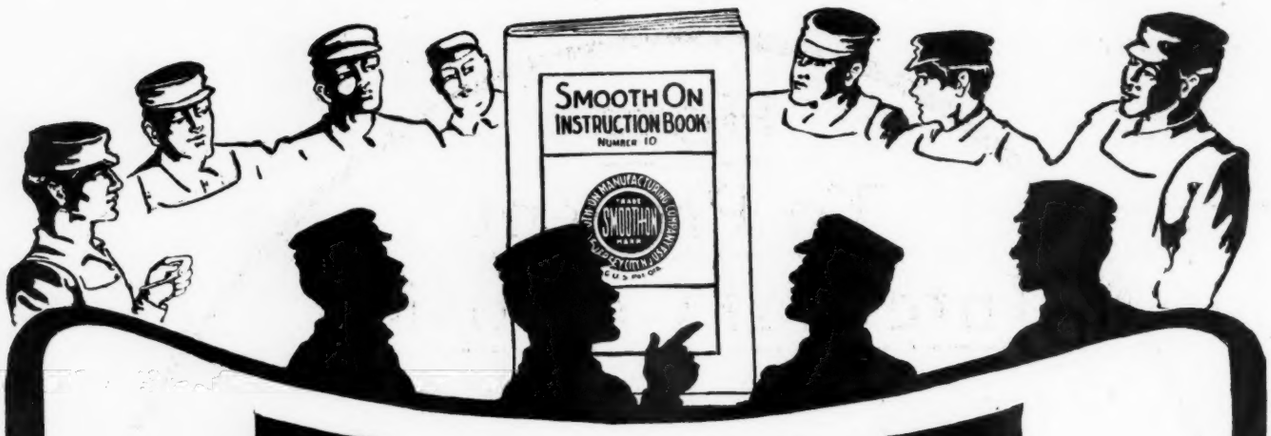
"How"
No. 3
Next Week



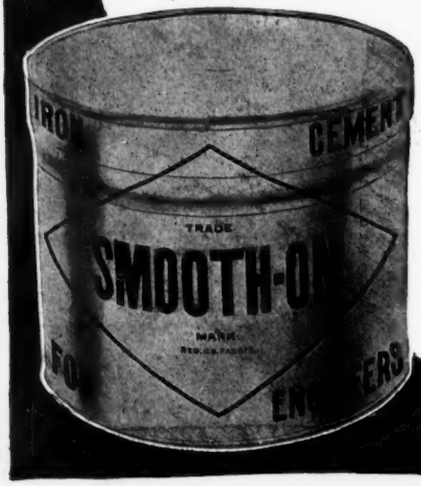
FREE

INSTRUCTION BOOK

SEND FOR IT TODAY.

This book should be within instant reach of every engineer. It tells clearly, by photograph and formula, how to use the well-known Smooth-On Iron Cements in repairing boilers, engines, castings, tanks, joints, etc.

Used according to instructions, Smooth-On Cements will save more actual time and money in the engine and boiler room than any single product manufactured. Their uses are innumerable, and their repairs absolutely permanent.



Smooth-On Mfg. Co.

572-574 Communipaw Ave.

Jersey City, N. J.

Chicago, 231 N. Jefferson Street

San Francisco, 94 Market Street

London, 8 White Street, Moorfields, E. C.

ARE YOU UP AGAINST IT?

"We are up against it at this plant. We have a fairly large size suction line for supplying the turbine condenser with water by means of a centrifugal pump.

"We made a single strainer having eight times the area of the pipe, and stuck it in the line. We can't run more than an hour without shutting down for a longer time to clean.

"Can you help us out? Do you make a Strainer that can be cleaned without interfering with the operation? We want to be sure about that **continuous operation.**"

This came over the telephone the middle of last month. What did **we say?** Not much—they were losing money. In **three days** there was a **Twin Strainer** in that line. Did it do the business? Well, we just called up again and got this:

"We appreciate your interest, but it is unnecessary for you fellows to take up your time calling us to learn if that Strainer is the thing or not. We have been running ever since we started, and if it gives us the slightest trouble, we will do like we did before—**'holler'.**"

There are loads of plants in the same fix, and their operators are either like the fellow in "Confessions of an Engineer" (POWER, Nov. 28th), or just trying to worry along from season to season. Get **ahead** of the game and be **prepared** for the next worst, which comes along with the winter high water.

Elliott Company, 6908 Susquehanna Street, **Pittsburg, Pa.**

BUILDING THE PANAMA CANAL.

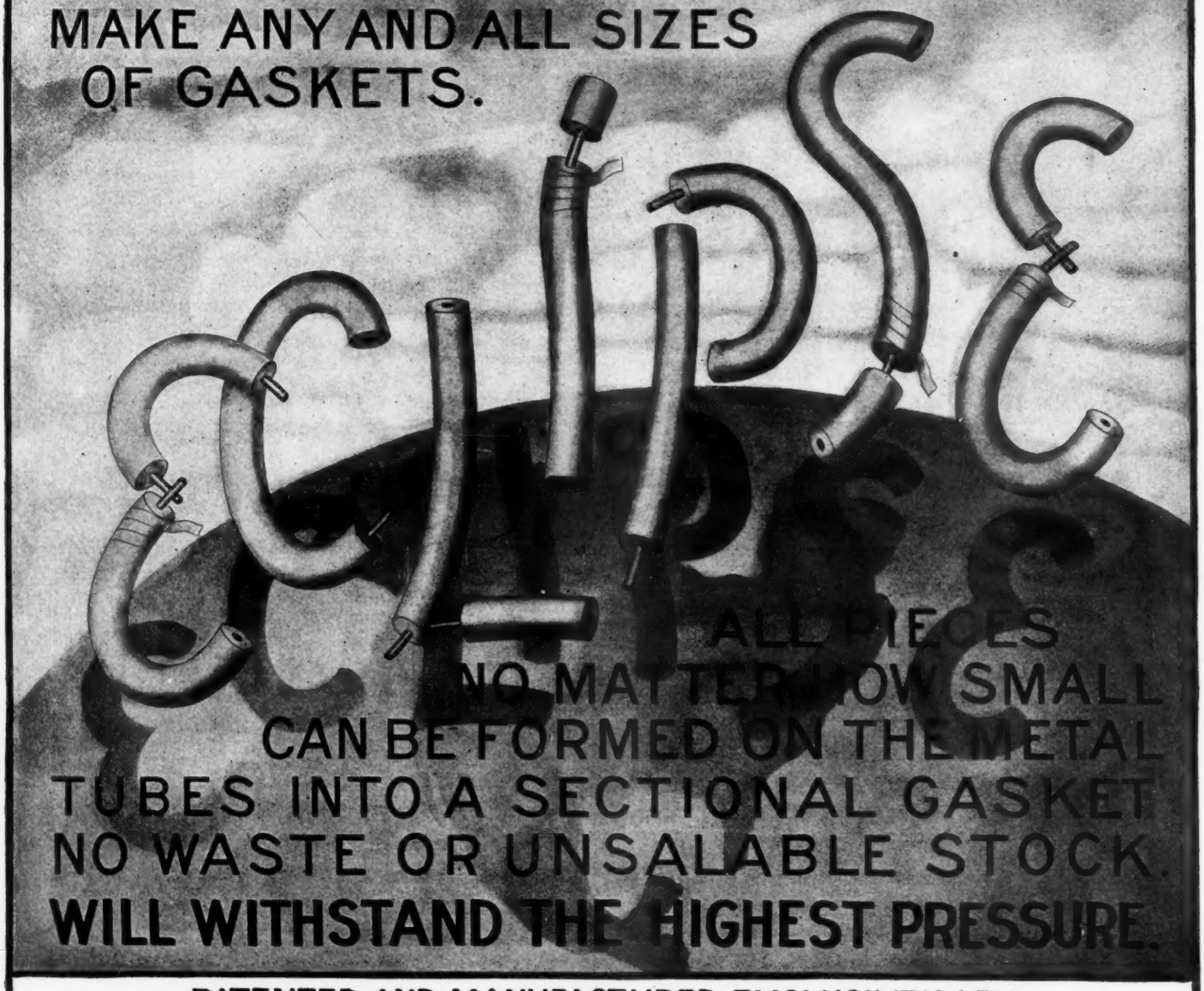
WAS a wonderful undertaking, but it will be completed in a great deal less time than the engineers original estimate. The *Liberty Cleaner* has frequently undertaken tasks in cleaning *badly scaled boilers* that were *comparatively* as difficult of accomplishment, but it has *always made good.* No matter how bad a *case of scale* you may have, *the Liberty will cure it,* and you will be surprised how *quick and thorough* it will do the work. If you have scale in your boilers it requires no argument to convince you that it should be removed, and there is *no tube cleaning device* that will accomplish the work as *speedily, efficiently* and at so *small expense* as the *Liberty.*

Let us send you a cleaner on trial, and if it fails to make good we don't want you to keep it. We make cleaners to meet all conditions for *large* or *small plants,* for *bent* or *straight tubes,* and for *either water* or *fire tube boilers.* Write for particulars and tell us whether you wish to use air, steam or water power. Also give type of boilers and size of tubes.

Liberty Mfg. Co., 6705 Susquehanna Street, **Pittsburg, Pa.**

ECLIPSE SECTIONAL RAINBOW GASKET

CAN BE ADAPTED TO ANY SHAPE AND MAKE ANY AND ALL SIZES OF GASKETS.



ALL PIECES NO MATTER HOW SMALL CAN BE FORMED ON THE METAL TUBES INTO A SECTIONAL GASKET NO WASTE OR UNSALABLE STOCK.

WILL WITHSTAND THE HIGHEST PRESSURE.

PATENTED AND MANUFACTURED EXCLUSIVELY BY

PEERLESS RUBBER MANUFACTURING COMPANY

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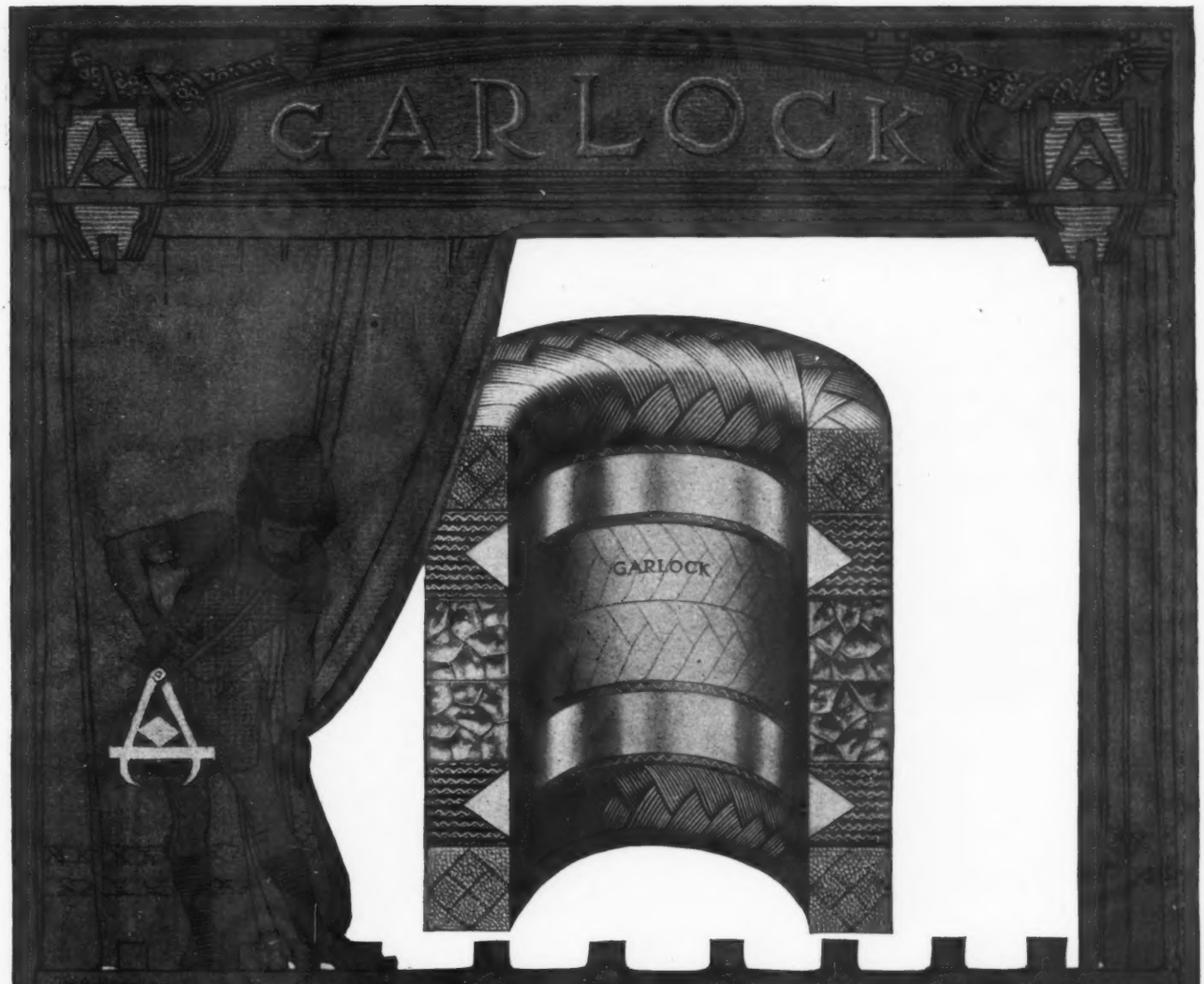


Garlock Combination Hydraulic Packings

To meet the varying conditions and temperature to which hydraulic packing is subjected, we have found that the best results can be secured by combining in sets two or more of our different packings. In the above illustration is shown a set of our Duo Hydraulic, style No. 960, which is composed of braided copper, metal wedge and water-proof hydraulic ring. This combination will hold a pressure of 3000 pounds, as has been repeatedly demonstrated in the steel mills, blast furnaces and railroad shops, where the demands on packing are most severe. We make many other combinations suitable for different requirements in hydraulic work.

A postal card will bring our catalog

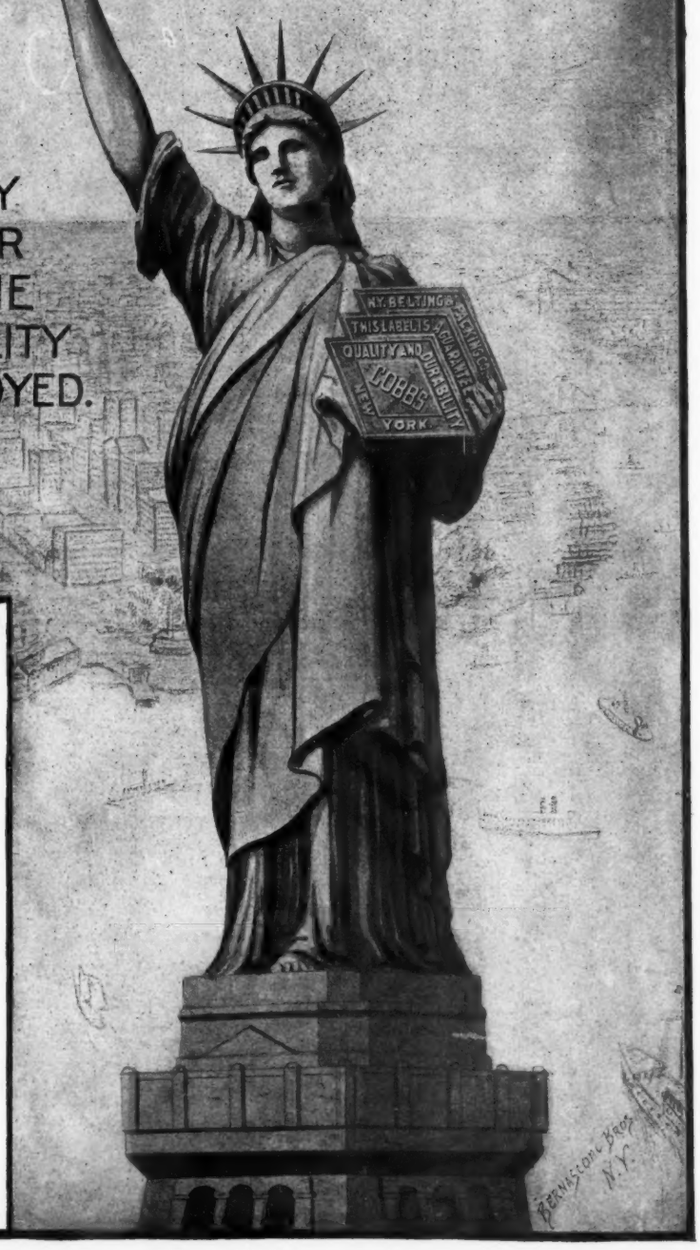
THE GARLOCK PACKING COMPANY - Palmyra, N. Y.

Branches in Principal Cities

COBB'S PISTON AND VALVE ROD PACKING

IS AN ENLIGHTENMENT TO THE ENGINEERING WORLD

BY USING
COBB'S PACKING,
ENGINEERS ENJOY
FREEDOM FROM WORRY
OWING TO THE SUPERIOR
CONSTRUCTION OF SAME
AND THE EXCELLENT QUALITY
OF THE MATERIALS EMPLOYED.



MANUFACTURED EXCLUSIVELY BY THE

NEW YORK BELTING AND PACKING CO. LTD.

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TRADE PENBERTHY MARK.

SECTIONAL VIEW

Price $2.25

Showing solid construction of gage—and simple automatic action and drip-less pet cock

SAFEGUARD

AUTOMATIC WATER GAGE

This mechanically correct gage assures absolute safety and protection against the dangers which result when the glass is broken in an ordinary gage.

The upper seat is designed to leak for purposes solely of sureness of operating at the proper time. Only dry steam escapes and in small quantity, hurting no one. The leak equalizes the pressure in the glass and the boiler pressure, and the *Balls Cannot Stay Seated Unless Glass is Broken.* This fact is positive and any gage not made to leak on the upper arm is unsafe. The lower seat is made absolutely tight and when glass breaks the ball seats instantly and *Not a Drop of Water and No Steam Escape* to injure anyone.

It operates on any pressure from two pounds up, is tested to 300 pounds, is very simple and strong, and is self-cleaning by the action of the blow-off vibrating the balls.

You need the "Safeguard" in your boiler room—try it.

If your dealer will not supply you—write us and we will ship direct. $\frac{3}{8}$" and $\frac{1}{2}$" shank $2.25, $\frac{3}{4}$" shank $2.75—a small extra charge being made for glasses over 14 inches long. Circular matter on request.

PENBERTHY INJECTOR COMPANY

355 Holden Ave., Detroit, Mich., U. S. A.

Extract Every Heat Unit From Low Grade Fuels

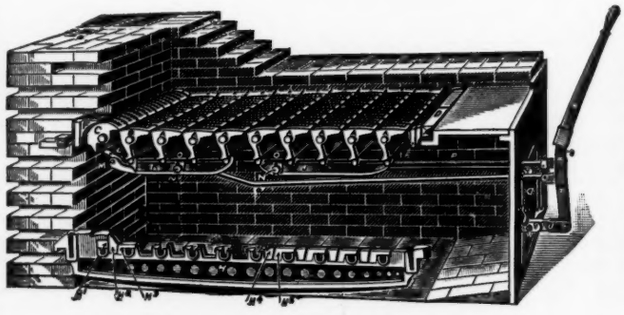

Plate No. 1. Normal Position of Grate.

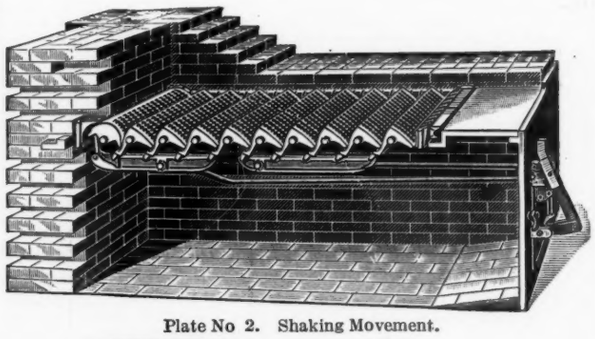

Plate No 2. Shaking Movement.

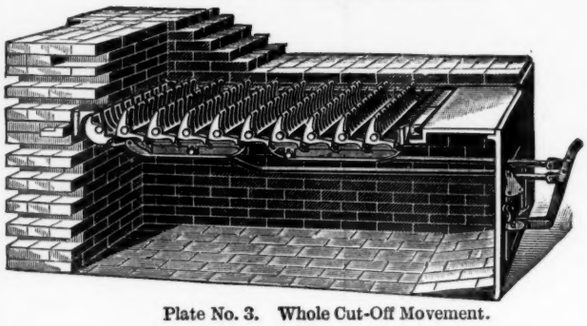

Plate No. 3. Whole Cut-Off Movement.

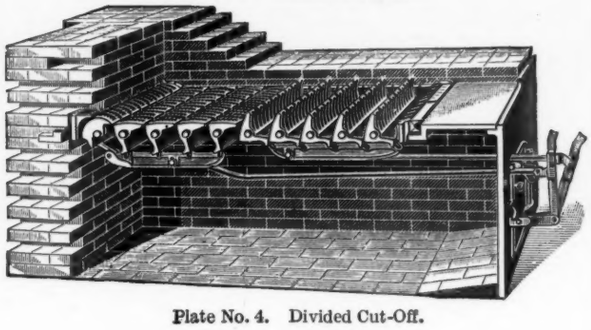

Plate No. 4. Divided Cut-Off.

McClave Grates and Argand Blowers

Are more than parts of the boiler furnace—they form a system of complete combustion.

This combination makes it possible for you to use a low grade fuel successfully.

The truth of this has been proved by the CO_2 Recorder and many other tests.

For example, No. 3 Buckwheat used on these grates with the Argand Blower will give results as satisfactory as high grade coal on ordinary grates.

Plates 2, 3, and 4 show the McClave movements necessary in handling without waste such cheap fuels as the lower grades of anthracite and bituminous coal. Rice, birdseye, buckwheat slack, screenings, etc., may all be used with good results.

Argand Steam Blower

Write us for full information—ask for Catalog "G."

McClave-Brooks Company, Scranton, Pa.

Branch Offices:

New York, 351 Fulton Bldg.
S. C. Smith, N. Y. Manager.

Pittsburg, 1007 Empire Bldg.
Chas. N. Hays, Sales Agent.

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CONSOLIDATION COAL

The Man Behind The Shovel Needs Good Coal

Do You See That He Gets It In Your Plant?

Anderson Bend, West Fork River. Consolidation Mines, Anderson, Highland, Middleton and Chiefton.

It is an old saying, "the poor workman blames his tools." Why should you handicap the good workman by giving him poor tools? Your power plant engineer is your skilled workman and you should assist him by giving him the best kind of tools with which to do his work. You expect him to develop power, and to get the power he needs the coal that will produce heat. Only coals that possess a certain percentage of combustible matter will meet the requirements of the man that needs heat. Carbon is the greatest single factor in combustion; the more carbon in the coal, the more you get the benefit of the stored-up energy that developes into heat and power.

The Consolidation Coal Company, by thoroughly testing its different classes of coal, determines which kind is best adapted to each type of power house requirement. Whether you use Georges Creek Big Vein Coal, Somerset Smokeless Coal, Fairmont Steam Coal, or Miller's Creek Block Coal; each will be found to possess some definite property that will make them valuable to you.

Consolidation Coal contains the Carbon; it makes the steam, and it does the work. Tell us what your man with the shovel needs—what kind of power plant you have, its location, and its purpose, and we can name the kind of coal to fit.

Ask us to send you our interesting booklet, "The Coal to Burn and How to Burn It."

The Consolidation Coal Company

INCORPORATED

F. W. Wilshire, Gen. Mgr. Of Sales, 1 Broadway, New York

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Louisville, Ky., G. E. Davis, Mgr., Paul Jones Bldg.
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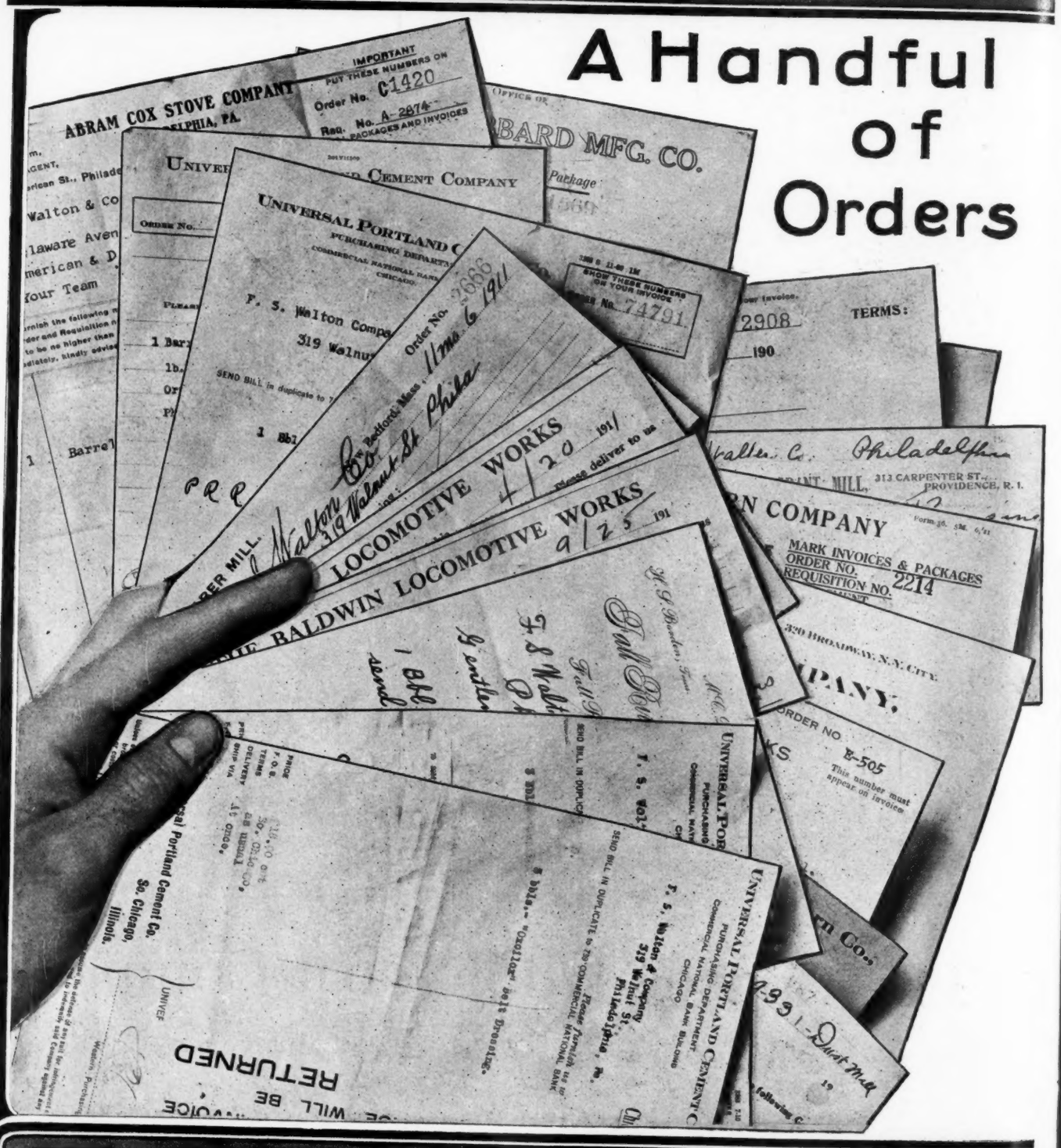

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It makes them pull like chains, and the longer it is used the less quantity is required and the better the belts become.

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12-26 11

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The Dartmouth Manufacturing Corporation operates one of the largest textile mills in the United States. Note what they say in the following letter—and we can show you scores of letters like it.

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NEW BEDFORD, MASS., July 26, 1909.

The Burt Manufacturing Company, Akron, Ohio.

DEAR SIRS: Yours of the 23rd, in regard to the two "Burt" Unit Type Filters, received. They are giving us satisfaction, and would say in that respect you may enter our order for one more Unit same as last shipped us, at same price. Prompt shipment desired. Yours truly,

Hatton Langshaw, Sup't.

Send for our 128-page Catalog.

The Burt Mfg. Co., 232 Main St., Akron, O., U. S. A.

Largest Manufacturers of Oil Filters in the World.

We also manufacture a complete line of Exhaust Heads and Ventilators.

POWER

Vol. 34 NEW YORK, DECEMBER 26, 1911 No. 26

We Hereby Offer a Prize of Fifty Dollars Gold

to the man who, before March 1, 1912, submits the best practical article on

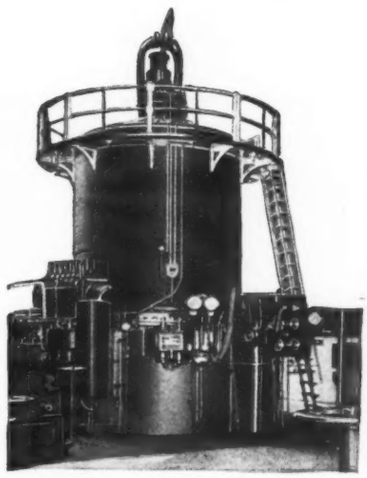
"Running a Steam Turbine"

These gentlemen have consented to pass upon the merits of the articles submitted and to decide who is entitled to the prize:

HENRY G. STOTT
Superintendent of Motive Power,
Interborough Rapid Transit Co., New York

JAMES D. ANDREW
of the Boston Elevated Railway Company

ORLAFF E. OLESON
Chief Engineer, Fisk and Quarry St. Station
of the Commonwealth Edison Company of Chicago



WHAT would you do, you who have never seen a steam turbine except in a picture-book, if you were led alongside a machine like one of these and told to run it? Would you know what precautions to take before you opened the throttle? Would you know the purpose of the various valves and levers about it? Would you know what to jump for if anything went wrong, what to look out for to prevent anything from going wrong? Could you diagnose impending trouble from its first symptoms and stave it off? Could you take a machine which would not stay packed and find out why, and pack it to stay?

The three manufacturers of large turbines in the United States have put out some five million kilowatts capacity, mostly within ten years, and the bulk of this in the past half dozen years. If present indications hold, there will be a greater increase in the next half dozen years.

There will be men needed to run these turbines. Men will not be needed to run the piston engines which they will displace.

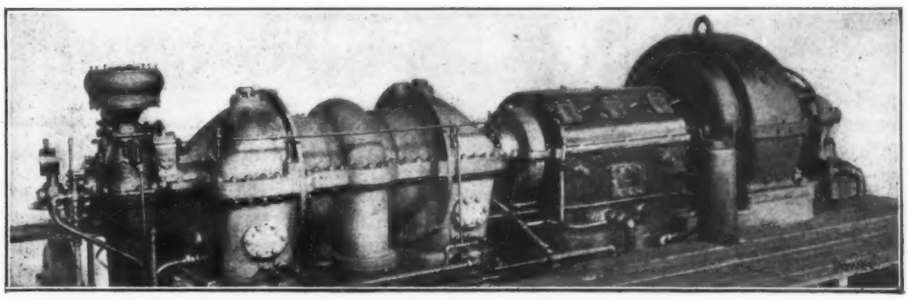
The stationary engineer who wants to keep up with the times, who wants to be in a position to take advantage of offering opportunities and grow with his years and with the progress of his vocation, must learn about steam turbines.

Most of the available literature upon the subject deals with principles, with type differences, efficiencies, etc. There is little or nothing in print to tell a man how and why a turbine runs, and how to make it run and keep it running; how to start it up without distorting the disks or the casing so as to cause the blades to interfere; how to adjust clearances, the management of the step in the vertical type; the function of the bypass valve between stages, the care of the oil-circulating and cooling system, the means taken to hold glands tight against twenty-nine inches of vacuum.

The prize article will be printed in POWER as such and paid for at the regular rate in addition to the prize money.

Such of the other articles as contain points not brought out in the paper which receives the prize, may be used in POWER in whole or in part, and their authors recompensed in accordance with the use made of them.

The articles will be judged not upon their literary merit, but by their practical value to the man of average education and intelligence who wants to learn how to run a steam turbine.



New Generating Station, Portland, Ore.

By Edward A. West

A 6000-kilowatt plant containing two turbogenerators and one engine-driven unit.

The former generate alternating current at 2300 and 11,000 volts for lighting and long-distance transmission, and the latter direct current at 625 volts for railway service.

Portland, Ore., with its population of over 207,000, is supplied with light and power by the Portland Railway, Light and Power Company. Probably in no better way can the marvelous growth of the electrical industry in Portland be shown than by comparing the city's present consumption with that of 10 years ago. There were 1960 users of electric light, and approximately 100 consumers of electric power, in 1901; on January 1, 1911, there were more than 27,000 customers for light and power, the connected motor load totaling 28,000 horsepower, and the lighting load exceeding the equivalent of seven-hundred thousand 16-candle-power lamps. In addition, there are over 15,000 electric irons in use.

The territory covered, as shown in Fig. 1, which also gives an idea of the high-tension distributing system, is served by three steam plants, sixteen substations and four hydroelectric plants, having a total rated capacity of 54,000 kilowatts and feeding an area of approximately 856 square miles.

During the greater part of the year about 95 per cent. of the demand is taken care of by the hydroelectric plants, but at such times of the year as the water in the Willamette and Clackamas rivers is low, the steam auxiliary plants are called into service. For this reason, and also in case of trouble on any one of the high-tension lines, these plants are always kept ready for immediate service. In this connection the economical use of fuel would be of utmost importance were it not that during the greater part of the year sawdust is available as fuel. However, station attendants must be at hand or within call at all times, but as each of the generating plants has substation equipment the duties of the operators are twofold; with the fire-room force this does not apply.

Station L

To handle the increased summer load it was necessary last year to further supplement the hydroelectric plants by the construction of station L, located in East Portland, within a short distance of the heart of the city, and on the Willamette river. Its proximity to the river makes available the required water for condensing purposes.

On account of the unstability of the ground, it was found necessary to drive over 3000 piles, spaced at 3-foot centers; many of these were spliced and driven to a depth of over 150 feet. After the butts of the piles had been sawed off to a uniform level, a concrete slab was placed over them to a thickness of 3 feet, reinforced with a network of 50 tons of ¾-inch steel bars. Fig. 2 shows the piles after being sawed off, ready for the concrete. To arrest the settlement of the foundations (where they rested on a quicksand belt about 20 to 30 feet thick, and from 50 to 65 feet below the floor of the station) the station foundations had to be surrounded by a fill of about 80,000 cubic yards of gravel, sand and loam.

This fill was carried up to the level of the station floor and extends west about 40 feet, sloping out to the harbor line of the river, and south about 300 feet across an old slough. On the east side of the station the fill is carried level over all the slough, and to the adjacent banks within about 1 foot of the elevation of the station floor, which is equivalent to 32½ feet above the low water of the river. This fill, by confining the fluid masses, has equalized the pressures and practically stopped all settlement.

Recently test sheet piling of I-beam and lock-bar type was driven, it being thought that with a tight steel casing inclosing the quicksand belt, all further shifting of foundation material would be stopped. This is a matter of much importance, as serious results might ensue should any dredging be done in the harbor.

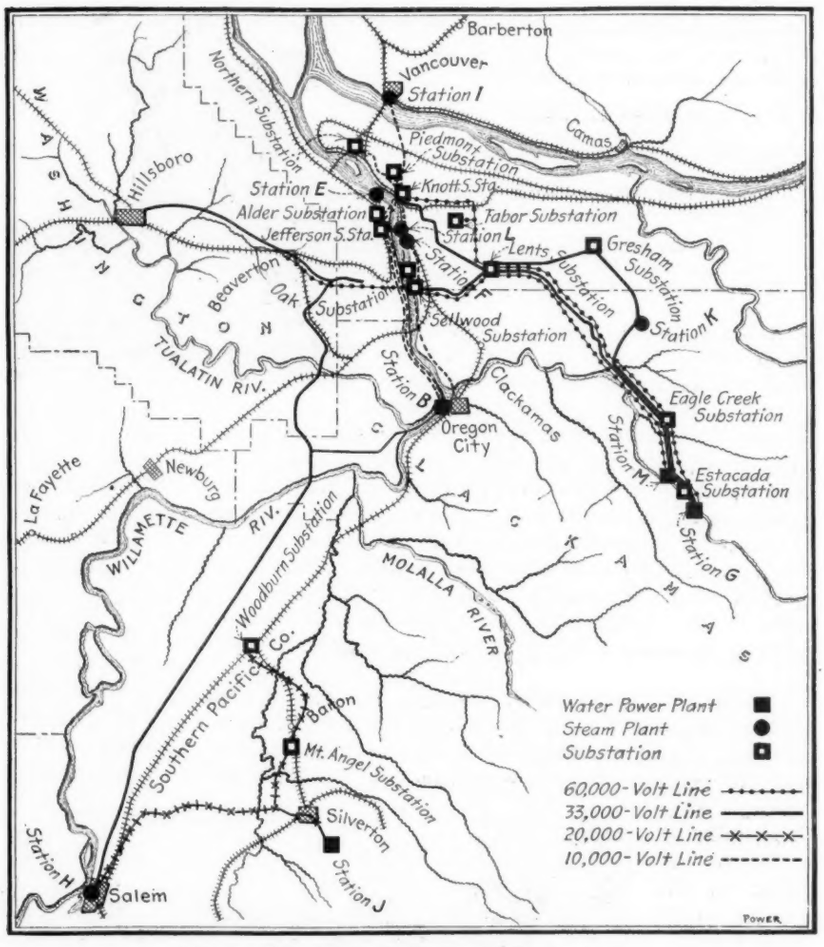


Fig. 1. Map Showing Distribution System

Building

Preliminary plans for this station were drawn by the company's engineers, and the final and working drawings were

made by E. W. Clark & Co., of Philadelphia, the best features of both sets of plans being embodied in the design of the station.

The building itself is 160x130 feet, and of reinforced-concrete and steel construction with brick gables and a brick side wall on the north to allow for extension. An exterior view of this is shown in Fig. 3. There is also a 112x54-foot wooden storage bin of mill construction, for sawdust, located outside the station at the side nearest the boiler room. A double-track railway trestle runs from the sawmill of the Inman-Poulsen Lumber Company to the storage bin.

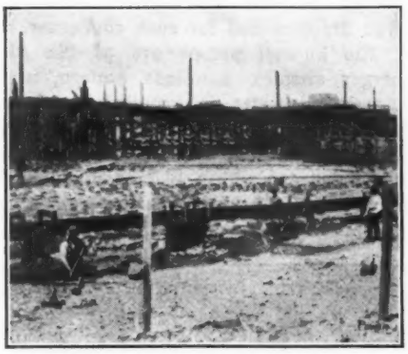


FIG. 2. FOUNDATION PILING

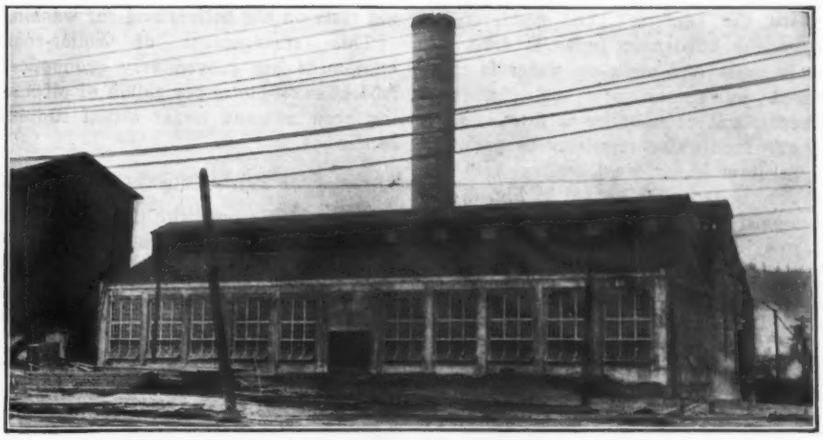


FIG. 3. EXTERIOR VIEW OF PLANT

BOILERS

The boiler room contains eight Babcock & Wilcox boilers, each having a guaranteed evaporation of 30,000 pounds of water from and at 212 degrees. They are set in batteries of two each, with a passageway between each battery. A space 20 feet wide between the two middle batteries is occupied by two 17x10x15-inch Worthington outside-packed plunger feed pumps, fitted with Fisher governors. Above the feed pumps are two Hoppes feed-water heaters, which utilize the exhaust steam from the auxil-

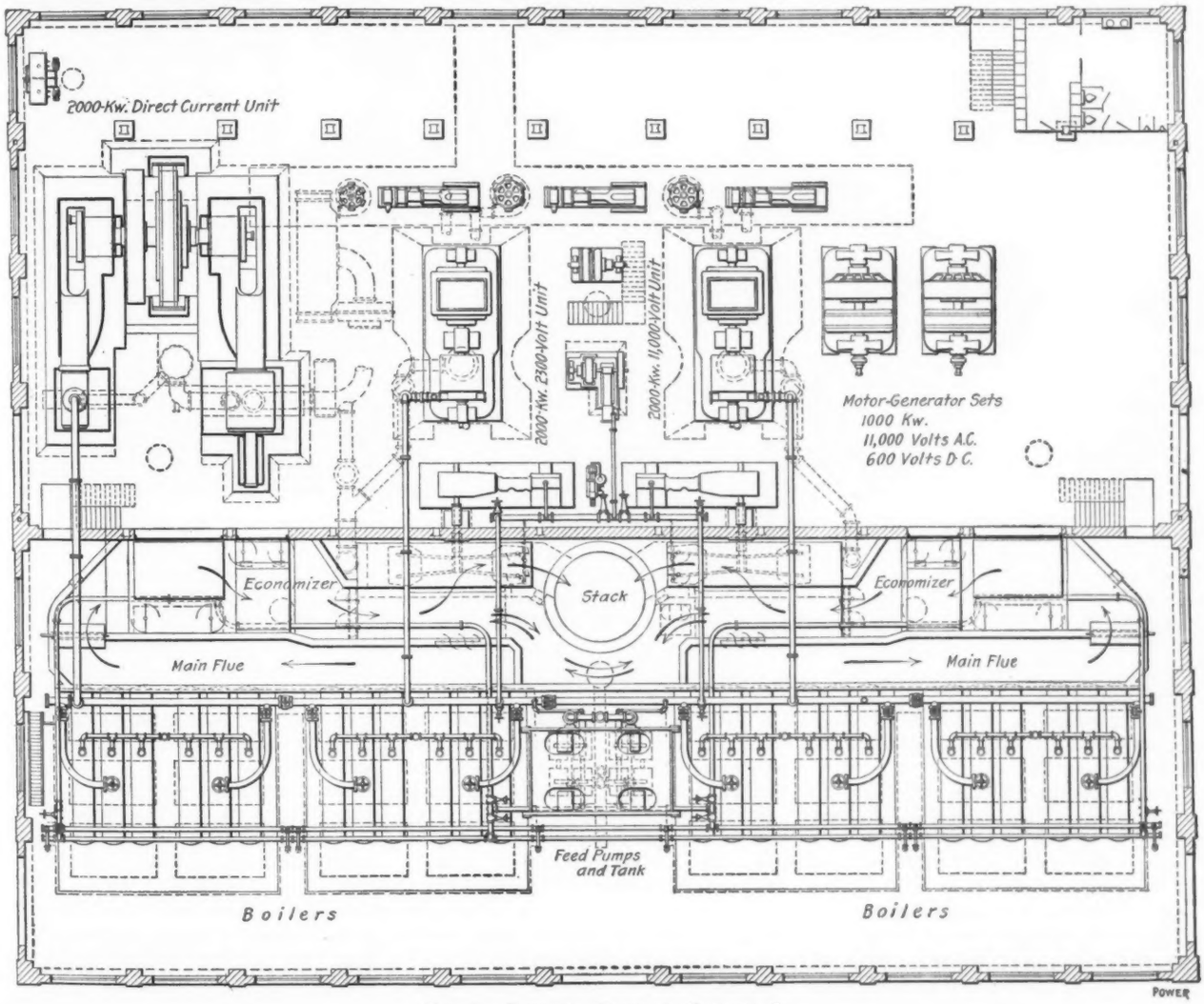


FIG. 4. GENERAL PLAN OF STATION L

iaries and the feed water discharges from the pumps through two Green economizers.

A supply tank having a capacity of approximately 10,000 gallons is located above the heaters. The condensation from the condenser hotwells from the main units and make-up water is measured by means of four Hammond meters, and each boiler is fitted with a Copes feed-water regulator to maintain a constant water level.

The furnaces, as shown in Fig. 6, are designed with large dutch ovens, the grates having an area of 148.7 square feet, or a ratio of grate area to water-heating surface of 1 to 27.5. The sawdust fuel is fed automatically by two conveyers which bring it from the storage bin.

At the rear of each boiler is a three-panel Hammel oil burner, fitted with checkered grates and draft doors for regulation. The arrangement is such that a combination of both fuels may be used at one time or either may be burned separately.

There are four storage tanks for oil, located underground and about 80 feet from the station. Two of them have a capacity of 5000 barrels each, and the oil is pumped from them into smaller ones of 500 barrels capacity each, by a motor-driven plunger power pump. The oil used during each watch is measured in the smaller tanks and is pumped from them to the burners by means of two Knowles steam pumps equipped with Witte regulators for maintaining a uniform pressure of 50 pounds. An auxiliary feed pump is also provided for making tests on the boilers and for washing.

This arrangement of boiler-room equipment has proved very economical, 5.04 kilowatt-hours per gallon of oil having been attained under actual running conditions.

Prime Movers

The engine room, with the balcony for oil switches, transformers and electrical equipment (see Figs. 5 and 8), is so arranged that everything is controlled from the main floor, thus doing away with the necessity of running up and down stairs. There are at present installed two four-stage, condensing, horizontal, Curtis turbines running at 1800 revolutions per minute, one connected to a 2000-kilowatt, three-phase, 60-cycle, 11,000-volt generator and the other to a 2000-kilowatt, three-phase, 60-cycle, 2300-volt generator. In addition to the turbine units there is a 34x68x54-inch horizontal cross-compound condensing Hamilton Corliss engine running at 90 revolutions per minute and direct-connected to a 2000-kilowatt, 625-volt, direct-current generator; this unit is for railway service. Space is provided for a fourth unit which will probably be a 5000-kilowatt horizontal turbine. The foundations of the turbines are cored out and the condensers and hotwell pumps are set directly underneath.

The condensers are of the Alberger surface type; the one for the engine having a capacity of 50,000 pounds of steam per hour and the other two, 55,000 pounds each. Separate dry-vacuum pumps of the steam-driven flywheel type are provided for each condenser.

The hotwell pumps are of the Alberger simplex valveless pattern, and circulating water is supplied by three centrifugal pumps of R. D. Wood make, two with 16-inch suctions for the turbines and one with a 14-inch suction for the engine. These pumps are located in a tunnel and are driven through vertical shafts by motors located on the engine-room floor. The suction pipes are carried under the concrete mat in a tunnel having a bulkhead at the river end; the discharge tunnel lies beneath this at an elevation which always insures a sufficient seal and the condensers discharge into this tunnel through a hole in the mat.

The exciting current for the turbo-generator sets is supplied from one exciter set consisting of an 11x12-inch Skinner automatic engine, direct-connected to a 125-volt Allis-Chalmers generator. There are two 10x30-inch Allis-Chalmers Corliss engines, which drive two 18-foot induced-draft fans which maintain a draft of 0.6 inch when

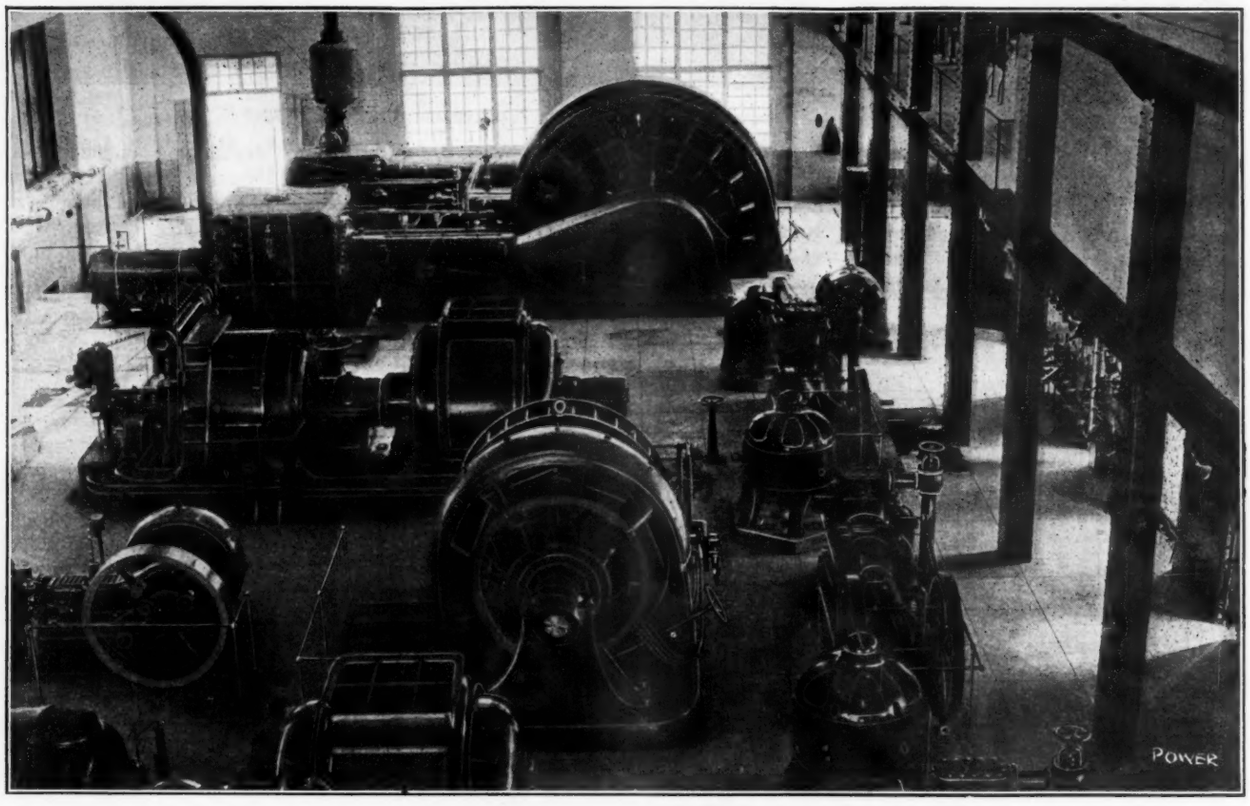


Fig. 5. General View of Engine Room

sawdust is burned alone. They are not used, however, when oil is burned, as the natural draft of about 0.3 inch is sufficient to secure complete combustion with this fuel. The stack, which is shown in Fig. 7, is of concrete and of the Webber patent type, 125 feet high, with an inside diameter of 12 feet. The lower 50 feet of this stack is cored out with 4-inch air spaces for cooling.

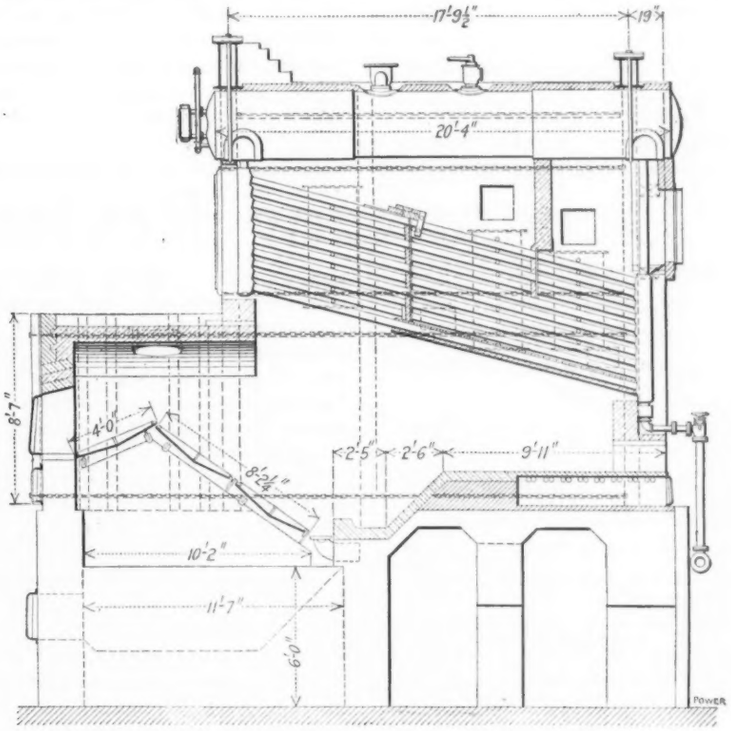


FIG. 6. SECTION THROUGH BOILER SETTING

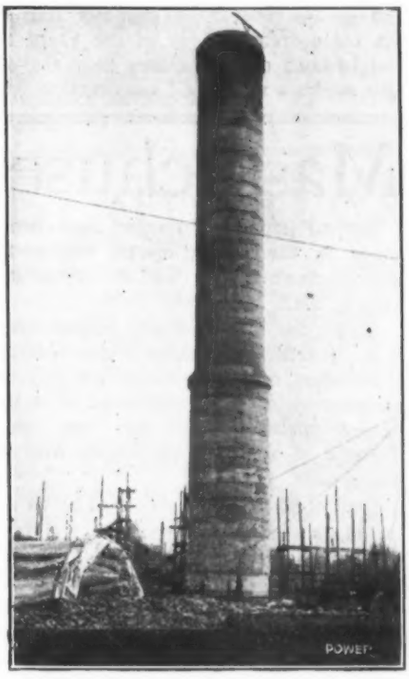


FIG. 7. CONCRETE CHIMNEY

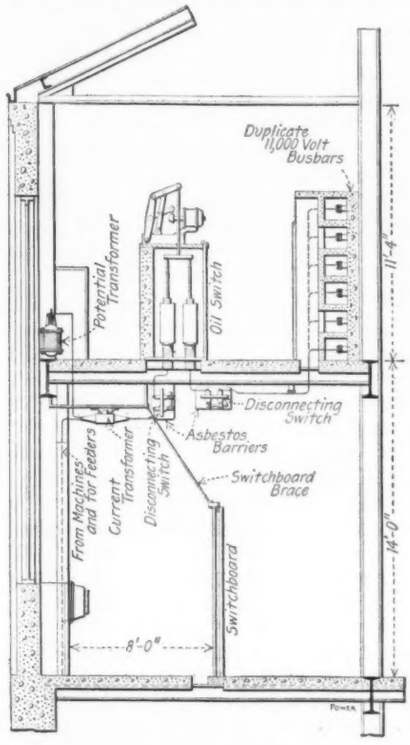


FIG. 8. SHOWING SWITCH AND BUSBAR STRUCTURE

AUXILIARY EQUIPMENT

In addition to the foregoing equipment there are a fire pump, a centrifugal pump for make-up water, pumping directly from the river, air compressors and other small auxiliaries which go to make this station one of the most modern and best equipped plants in the Northwest. The extensive use of recording thermometers and gages enables the operating force and those directing them to obtain very accurate and valuable records of the operating conditions.

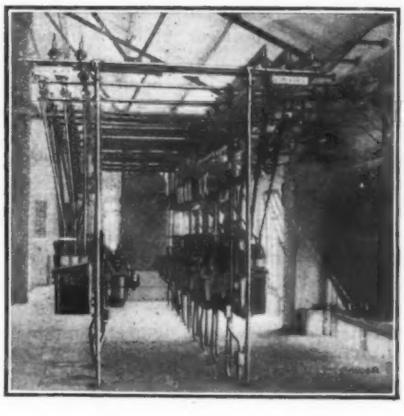


FIG. 9. 2300-VOLT BUSBARS

ELECTRICAL EQUIPMENT

As previously mentioned in the description of the generators, the alternating current is generated at two different voltages, namely, 11,000 and 2300. There are duplicate sets of busbars for each voltage and between these is a bank of transformers, making it possible to feed either or both the 11,000-volt and the 2300-volt busbars from either of the alternating-current generators. This affords a very flexible arrangement.

Fig. 8 represents the 11,000-volt switching equipment. In this case, as with the 2300-volt equipment, duplicate busbars are installed. Each feeder and machine is connected to both busbars through two sets of disconnectng switches and motor-operated oil switches, allowing any switch to be cut clear of the busbars, feeders or machines for repairs without interruption to the service. Through the remote control the operator may open or close any of the oil switches while standing in

FIG. 10. 11,000-VOLT OIL-SWITCH COMPARTMENTS

front of the switchboard, thus saving time and confusion in case of trouble. Asbestos board barriers have been used to advantage above and between the disconnecting switches.

The means of supporting the switchboard have proved of great advantage; instead of bracing from the wall to the top of the board the supports run at an angle from the top of the board to the I-beams of the balcony floor above; this makes a more rigid construction, besides giving more clearance back of the board. The pipe supports of the switchboard are entirely clear of the ground, making it impossible for a man working on the back of the board to short-circuit with the ground.

The 600-volt railway system has been worked out along the lines of ordinary practice, the neutralizing being done on the negative side.

The switchboard panels are all of the standard General Electric type, automatic breakers being used on each railway feeder. In the case of each of the 2300-volt alternating-current power and lighting feeders, automatic induction regulators are installed.

All control and lighting wiring is run in metal conduit concealed in the station walls and floors, and the machine and high-tension cables are run in clay and fiber ducts enveloped in concrete, giving the whole a concrete-beam effect.

Massachusetts License Law Revised

Important changes have been made in the application for examination, and in an appeal therefrom; also the boiler-horsepower rating has been altered slightly and a turbine rating appended.

Additional changes of minor importance are pointed out.

The amended rules take effect Jan. 1, 1912.

Several important changes have been made in the Massachusetts engineers' and firemen's license law, to take effect Jan. 1, 1912.

Under the old rules any engine over 8 hp. (exclusive of those under federal jurisdiction, on road vehicles or in private residences) must be in charge of a licensed engineer. This has now been changed to apply to any engine over 9 horsepower.

Section 80 has been amended so as to include a designation of the terms "operate," "operated" or "operating," where used in the law, as applying to any person who, under the supervision of the licensed person in charge, operates any appurtenances of a boiler or engine; provided that there is not more than one such person employed for every licensed person and that any such operating must be in the presence of and under the personal supervision of the latter person.

That part of section 81 which pertains to the application for licenses has been changed so that the applicant must apply to the state inspector of boilers for the city or town in which he resides instead of to the examiner of engineers for the said town or city. Also, the application blanks are to be obtained from the boiler-inspection department of the district police instead of the blanks being furnished by the examiner. In this section the requirements for examination are now set forth definitely as follows:

"To be eligible for examination for a first-class fireman's license, a person must have been employed as a steam engineer or fireman in charge of or operating boilers for not less than one year or he must have held and used a second-class fireman's license for not less than six months. To be eligible for examination for a third-class engineer's license, a person must have been employed as a steam engineer or fireman in charge of or operating boilers for not less than 1½ years, or he must have held a first-class fireman's license for not less than one year. To be eligible for examination for a second-class engineer's license, a person must have been employed as a steam engineer in charge of a steam plant or plants having at least one engine of over 50 hp. for not less than two years, or he must have held and used, a third-class engineer's license for not less than one year, or have held and used a special license to operate a first-class plant for not less than two years; except that any person who has served three years as apprentice to the machinist or boiler-making trade in stationary, marine or locomotive engine or boiler works and who has been employed for one year in connection with the operation of a steam plant, or any person graduated as a mechanical engineer from a duly recognized school of technology, who has been employed for one year in connection with the operation of a steam plant, shall be eligible for examination for a second-class engineer's license. To be eligible for examination for a first-class engineer's license, a person must have been employed for not less than three years as a steam engineer in charge of a steam plant or plants having at least one engine of over 150 hp., or he must have held and used a second-class engineer's license in a second-class or first-class plant for not less than 3½ years. The applicant shall make oath to the statements contained in his application, and the members of the boiler-inspection department are authorized to administer the oath."

The old rules provided that if an applicant successfully passed the examination a license should be issued to him within six days after the examination. This time limit has been omitted in the amendments. Furthermore, they provide that an applicant for a first- or second-class engineer's license, or for a special license to operate a first-class plant, or for a special license to have charge of a second-class plant, shall be examined by a board of three examiners, one of whom may be the chief inspector; and if the applicant is employed, one member of the board shall be the state inspector of boilers for the city or town in which the applicant is employed.

Formerly a license remained in force for three years or until revoked for incompetence or untrustworthiness. Under the new rules a license shall remain in force indefinitely unless suspended or revoked for incompetence or untrustworthiness, except that a special license shall not remain in force after the holder ceases to be employed in the plant specified in the license. Also, a person whose license is suspended or revoked shall surrender his license to a member of the boiler-inspection department. If a new license of a different grade is issued the old license shall be destroyed by the examiner.

Under the heading "Classification of Licenses" have been added two new classes—a "portable" class and a "steam fire engineers" class, the former applying to a person having charge of or operating portable boilers and engines, except hoisting engines and steam fire engines, and the latter applying to one who has charge of or operates a steam fire engine or boiler.

A change has also been made in the boiler-horsepower rating, it being determined upon the basis of 3 hp. for each square foot of grate surface or its equivalent, when the safety valve is set to blow at a pressure exceeding 25 lb. per square inch, and upon the basis of 1½ hp. for each square foot of grate surface or its equivalent when the safety valve is set to blow at 25 lb. per square inch or less.

The reciprocating-engine horsepower remains the same, but a turbine horsepower rating has been added. This is to the effect that a turbine engine shall

be rated at less than 9 hp. when the external diameter of the steam-supply pipe does not exceed 1¾ in.; at 50 hp. when the external diameter of the steam-supply pipe exceeds 1¾ in. and does not exceed 3½ in.; and at 150 hp. when the external diameter of the steam-supply pipe exceeds 3½ in. and does not exceed 5 inches.

Section 84, dealing with the right of an applicant to appeal, has been changed considerably. An appeal must now be made to the chief inspector of the boiler-inspection department, who shall appoint three members of the boiler-inspection department to act together as a board of appeal, one of whom may be the chief inspector (instead of appealing, as formerly, to the remaining examiners, three or more of whom acted as a board of appeal). Also, under the new rules an appeal must be made within one week (instead of one month) after the decision of the examiner, and the applicant has the privilege of having one first-class engineer present during the hearing of the appeal, but the latter must take no part therein. The decision of the majority of the examiners acting as a board of appeal shall be final if approved by the chief of the district police.

An additional section of the amended rules provides that a license in force on Jan. 1, 1912, may be exchanged for a license of the same class under the new rules upon application to the boiler-inspection department of the district police.

Notes on Grouting Bedplates

By F. C. Holly

General directions for grouting bedplates and precautions to be observed.

Materials used and a discussion of their adaptabilities.

While it is infrequent that an engine has to be raised and rebedded, such a course is sometimes necessary and has several times occurred in the writer's experience. In these instances the trouble was easily attributable to ignorance or carelessness in the original setting.

There are several materials available for engine-bed joints, including portland cement, iron borings, sulphur and lead. Of these the last is now but little used and the iron borings or rust joint so much used in former years have been almost entirely superseded by cement, which by reason of its adaptability to nearly all cases, its durability, strength and cheapness is conceded by practical men to be the best for the purpose.

Cement

Cement needs great care in its application and may be introduced under an engine bedplate that is from ½ to 6 inches up from the foundation. The proportion should be one part of cement to one of good sharp sand, and where the top of the foundation is uneven (which is often the case where "cobblestone" or gravel concrete is used in construction) and the joint is thin, the mixture should be introduced in the form of grout mixed to the consistency of cream.

The foundation should be thoroughly wetted, and dams of sand, clay or board, laid back from the bedplate from 2 to 4 inches, should be built all around the bedplate, rising above the latter about 2 inches. The grout may now be poured in, and at this point in the process great care is necessary in order to avoid air and water pockets. The most efficient way to avoid these and to insure an even flow of grout is by means of agitators made of ordinary band or tie iron, which should be inserted into the joint while pouring the grout and kept moving alternately in and out in the manner of a plunger. The flow of grout is very sluggish and it is well to remember the tendency of its heavier ingredients to stop flowing and settle while the water continues on its way, giving the impression that the joint is full of cement when it is perhaps half full of water. By agitating in the manner described, especially under the ribs, water is sucked out and the mixture keeps flowing, while the water rises to the top, some of it running off over the dam, and uniformity results.

Any attempt to run a grout joint between two flat horizontal surfaces without making provision to run off the entrapped air and water from under the ribs will result in trapping air and water under the ribs, and when the surplus material is cut away "skips" of various thickness will appear between the settled grout and the bedplate where the joint has failed to fill.

On the other hand, where a vertical filler is desired, such as anchor-bolt holes, it is necessary only to pour in the grout, which in all cases should be continually well stirred. The body of the mixture will find the bottom and the surplus water will rise and flow away when the hole is full.

On the girder-frame type of bedplate, where the space between the bedplate and the foundation is wide enough, the cement may be tamped into the joint; this method has the advantages of neatness and quick setting. The proportions should be the same but the mixture should be moistened only enough so that a test quantity will barely hold together when rolled in the hands into a ball. It should then be shoved into the joint in small quantities and rammed hard into place. When applied in this way, the cement will set quite hard in from 10 to 16 hours.

The writer considers 12 to 14 hours long enough for the cement to set before removing the dams from a grouted joint, when it will usually be found plastic and can readily be cut and smoothed by a trowel. When dry it should be painted to keep out the oil.

Rust Joint

The rust joint should be prepared by mixing a bucketful of iron borings with a half bucket of water to which has been added a handful of salt and as much sal ammoniac or sulphur. Guards made from flat iron bars passing all the way through the bedplate should be placed alongside at the edge of a rib to be packed and fastened to prevent the joint squeezing out in the process of packing. The ribs should be filled half way from each end.

In packing a rust joint only a small amount of material should be inserted at a time. This should be rammed thoroughly in place with a rammer made of flat iron 2 inches wide and as thick as will smoothly work in the joint. When properly rammed the joint will give forth a metallic sound similar to that caused by striking the bedplate itself with the hammer.

Sulphur

Sulphur does not adhere as readily to the iron face of the bedplate and the stone or concrete surface of the foundation as does either cement or the rust joint, but it has the advantage over all other materials in its capacity for flowing into very thin crevices and is one of the very few materials subject to practically no shrinkage in cooling.

Under horizontal bedplates, if the least movement occurs, sulphur is likely to shatter and work out in small pieces, especially if oil is present. Sulphur rots and softens under the effects of oil and should never be used as a joint under a steam cylinder. In melting sulphur for use in a joint a slow fire should be had and the kettle removed from the fire if the material should appear thick or "ropy" in the bottom, which is a sign that it is getting too hot. Properly melted sulphur pours like water and is by far the most flexible and easily handled of all the materials used for the purpose.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

The author meets an ex-hoisting engineer in the hotel lobby. He tells some interesting things regarding hoisting engines.

The types of hoists are explained and the advantages of each are pointed out.

Thanksgiving Eve of 1911 found me stranded in a large mining town of western Pennsylvania. The day had been cold and uncomfortable and toward dusk the leaden sky became overcast and a fine, sifting snow began to scud around the corners and down the street. The wind soon increased to a gale and by 9 o'clock the air was filled with a driving snow.

From time to time muffled pedestrians passed, and one, a miner, with dirty face, ill-fitting overcoat and greasy cap, from which hung a miners' lamp, shuffled past, doubtless on his way to his humble home after a day's work, performed hundreds of feet below the surface of the earth.

As he passed from view, I fell to musing as to why fate should be so kind to some and so regardless of the welfare of others, especially on a night such as this promised to be. An evening paper lay open upon my knee and, glancing at a headline, I read, "Lapse of Mind with Fatal Results."

This title had also attracted the attention of a stranger, who, like myself, was seated by the window, and who later introduced himself as Thomas Hunter. Turning to me, he said, in a somewhat apologetic manner: "The human mind is a wonderful piece of mechanism, but at times most fickle. It will serve a man faithfully for years; it can be so trained that one will automatically perform certain functions without thought or effort, and then it will suddenly play him false with such disastrous results as to cause vain regrets for a life time."

Something in the stranger's voice led me to surmise that there was a story back of his remarks worth hearing, and as he accepted a proffered cigar, I said, "You speak as one having experienced something of such a nature." As I spoke I saw that his hair was snowy white, although he was a comparatively young man.

"I have, he answered, and, continuing, said: "About twenty years ago I got a chance to fire a couple of steam boilers at a small colliery which eventually led to my becoming a hoisting engineer at the same mine. I have always been engaged in mine work.

"Things are different now to what they were in those days. Then the engines were crude in design and difficult to operate. About the first engine I had charge of worked after the plan of the old beam marine engine; that is, the engine was started by means of a starting bar, which operated the double-eccentric valve-gear. The valve-gear was hooked up after the engine got on a little headway. Working the valve levers and handling the throttle valve, and using both feet and hands in performing these operations, kept a man on the jump. In the old days the indirect hoist was used; for that matter, many are still being operated."

THE AIR WAS FILLED WITH A DRIVING SNOW AND OCCASIONALLY AN ILL-CLAD MINER SHUFFLED PAST

"Are there more than two kinds of hoisting engines?" I inquired.

"There are what are known as the direct, the indirect and the Corliss valve-gear hoist, which is something new and which permits of reversing the engine as readily as with the piston and slide-valve types of engine. The Corliss gear has lately come into use, as has also the electric hoist, in which the winding drum is operated by means of a motor."

"What is this direct hoist of which you speak?" I asked.

"The term 'direct hoist' means that the winding drums are mounted on the crankshaft of the engine. The two drums are either both keyed to the shaft or one is arranged with a clutch so that the drum can be revolved on the engine shaft while the engine is stopped."

"Of course, there is an object for that," I said.

"Yes; you see the same engine may hoist from two or more levels in the mine. When the engineer is hoisting from a 200-ft. level, the cages naturally travel the same distance, and when one cage is at the top of the hoist the other cage is at the 200-ft. level."

"Yes, that is evident," I replied.

"Then when coal is to be hoisted from the lower level when one cage is at the top of the shaft, the other, which would be at the 200-ft. level, would have to be lowered to the bottom of the shaft. Then" ——

"I see," I interrupted. "The drum is then thrown out of mesh with the clutch and the cage at the 200-ft. level is lowered to the bottom of the shaft."

"That's it," replied my friend, as he struck a match and relit his cigar. "Now, when the drum has been thrown in gear again, the cages operate as they did when hoisting from the 200-ft. level."

"How are the clutches arranged on such drums?" I inquired.

"There are different methods; on some drums the spiders are made with a four-fingered clutch. On the shaft is a key and the movable member of the clutch slides on the shaft and key. This mem-

ber is made with the same number of fingers as are on the spider, and when the two are engaged the drum revolves with the shaft.

"Another kind of clutch consists of a gearwheel keyed to the engine shaft and it meshes with a circular gear rack which is secured to the rim of the drum. Another type has the gear rack made in segments which are secured to the rim of the drum. The gears are thrown in and out of mesh by a combination of levers and gearing."

"How about the indirect drive?"

"Oh, yes," replied Hunter, "we rather sidestepped that subject. The indirect drive consists of a pair of engine cylinders which are connected to the same crankshaft, on which is mounted a spur gear. This gear meshes with a large gear which is keyed to the shaft on which the winding drums are mounted. The drum arrangement is practically the same as with the direct hoist. The engines of the indirect hoist must run fast in order to obtain the desired rope speed, whereas the direct-hoist engines run slower and make practically no noise."

"The gearing of the indirect hoist must be noisy," I suggested.

"Some are and some are not. It all depends on how they are kept up. The best of them make a little noise and most of them make more noise than is agreeable, but it is not so noticeable when the gear is meshed properly and the drums are tight; but once let the gear teeth wear and the bearings in the engine and drum boxes get loose, then a boiler shop sinks into insignificance, so far as noise goes. There are a lot of such engines running every day."

"It must be trying to the engineer."

"It is," was the reply. "I maintain that the engine room should be kept as quite as it is possible to have it. Then there is nothing to distract the attention of the engineer from his work. The direct-motion hoists are practically noiseless and the engineers like them."

"From that, I take it that the geared or indirect-motion hoist is being displaced by the direct-motion hoist."

"Well, each has its field. The geared hoist is adapted for a hoisting speed of 800 ft. or less per minute. First-motion engines, however, are used where the hoisting speed ranges from 800 to 4000 ft. per minute."

"Then there is a difference in the amount of coal the two types of engines will hoist per hour?"

"Well, the same weight hoisted by a first-motion engine may be handled by the geared type of hoist, but there will be a sacrifice in speed; the indirect engine, however, will not be so large as will be required with the direct hoist. For instance, it will require a direct-motion hoisting engine of from three to four times the size of a geared engine to hoist the same load, and the hoisting speed and the cost will increase in about the same proportion."

"You spoke of two types of winding drums; that is, the straight and conical face. What is the advantage of one over the other, if any?"

"Suppose I go back a little in the history of coal mining before I answer that question. Up to about 1840, coal seams were worked by tunnels and hoisting machinery was unknown. It was not even necessary, for coal mining in the hard-coal or anthracite regions had scarcely begun.

"As the coal supply became exhausted near the mouth of the tunnel or slope and the demand for coal increased, it became necessary to sink shafts as the expense of getting coal to the surface increased. These slopes were fitted with a single track and the hoisting apparatus consisted of a mule and whim. As the slopes became deeper, more powerful apparatus was demanded and the engine builders designed what is now known as the geared hoisting engine."

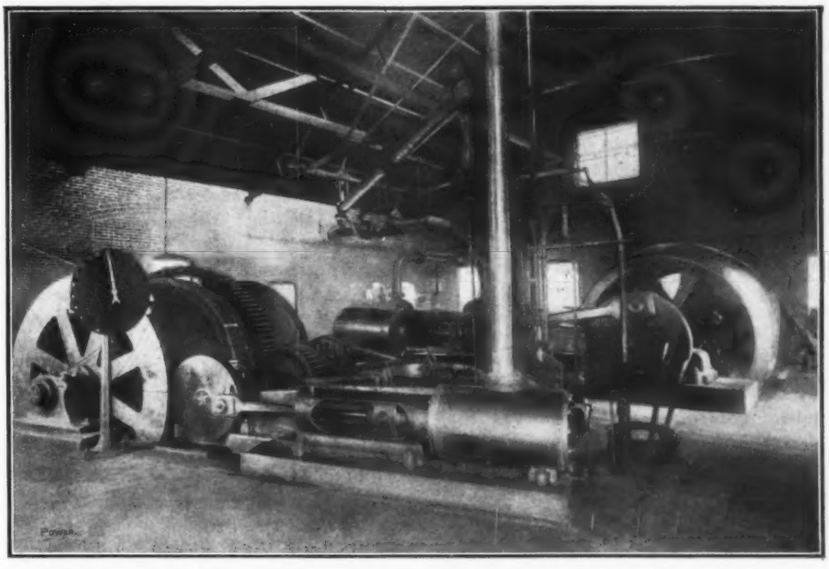
"Of course, these early engines have become obsolete," said I, moving nearer to the radiator as an extra-heavy gust of wind rattled the windows and the snow beat against them with renewed fury.

"There are a few running even now. Many of them were of the hook-link motion and were equipped with a wood lagged drum. Some of these engines were used in shaft work, but engines with improved valve-gear were soon designed for that kind of work and, being easier to handle, became more popular. As I have already said, the first-motion hoist with a high drum speed became popular when deep shafts were worked.

"The earlier type of drums with their plain wood lagging was made with a straight face. Later, the face was made of iron, having grooves for the hoisting rope, and this type was followed by the conical drum which also has a grooved face. These later drums are made conical in order to counter-balance the weight of the rope. For instance, when the hoist and car are at the top of the shaft, the cable has been wound on that part of the drum having the largest diameter and the pull or leverage will be greater than if the drum were of a smaller diameter, but of the same size from end to end."

"Yes, I see that," I replied, as I handed my friend another cigar.

"But," continued Hunter, "with the second car at the bottom of the shaft the pull on a straight drum would be equal to the weight of the car, cage and rope, which would more than offset the weight of the short length of cable, car and cage when they were at the top of the hoist.



GEARED AND DIRECT-ACTING HOISTING ENGINES WITH FLAT AND CONICAL WINDING DRUMS

"But having the drum made conical, the rope is wound over the smaller diameter of the drum, and, although the total weight of the cable, car and cage is the same as in the case of the straight drum, the leverage exerted by the cable is less and the weight of the rope is thus counter-balanced."

"I see," said I. "By that arrangement the heaviest load to be hoisted is started at a slow speed which increases as the top is reached."

"That's it exactly," was the answer. "It makes it easier on the rope and engine."

Just then a distant clock tolled midnight and we retired to our rooms, while underground, dust-begrimed miners were busy blasting out the coal which must be hoisted to the surface and which made hoisting machinery and hoisting engineers a necessity.

Efficiency of Reciprocating Engines

In an article under the above caption, which appeared in full in Die Zeitschrift *and was abstracted in the Oct. 31 issue of* POWER, *K. Heilmann drew some comparisons between the Wolf locomobile and the Stumpf uniflow engine.*

To this Professor Stumpf replies in the following with sharp criticism, depreciating the Wolf locomobile, and Mr. Heilmann defends his former attitude.

The recent contribution of Mr. Heilmann upon the heat efficiency of reciprocating engines (see Oct. 31 issue of POWER) prompts me to take the following exceptions:

It is not correct to refer to Fig. 8 (original article) as indicating a "uniflow" cylinder. It shows a combined uniflow and "reverse-flow" cylinder of which the action is 60 per cent. uniflow and 40 per cent. reverse-flow. Hence, such a cylinder has 40 per cent. of all the faults pertaining to the latter. Through overlapping of the two diagrams by 40 per cent. there occurs a thermal "blending" and a counter-current effect with corresponding losses. It is in the highest degree misleading to compare this cylinder, with the best multiple-expansion engines, when in addition to the introduction in the exhaust area of a choking release valve and the omission of all heating, everything has been done to obtain the worst possible results.

In one of the tables showing the results of tests with a boiler pressure of 176 pounds and an initial temperature of 523 degrees Fahrenheit, there is given a steam consumption per indicated horsepower-hour of 12.7 pounds. The Badenia Machine Works, of Weinheim, reported a consumption of 9.88 pounds per indicated horsepower-hour in an engine of the same size with a similar boiler pressure, and a temperature of 600 degrees Fahrenheit. (See *Zeitschrift* for 1911, page 504.)

It is an error to say that the duty, the number of cylinders and the valve construction have almost wholly lost their significance for heat utilization in the superheated-steam engine of today. As shown by the curves of cylinder efficiency* (*Gütegrad*) in Fig. 5 (original article) the Kerchove engine is superior to the Wolf engine and the uniflow is superior to both the Kerchove and the Wolf.

Disregarding true uniflow design, the Kerchove cylinder should be the best and the Wolf cylinder the worst, with those of Sulzer and Görlitz occupying intermediate positions. It is therefore not right, for comparison, to advance the Wolf engine as one of the best. Separated from the boiler, it must be designated as the worst, because it has the largest clearances and the largest detrimental surfaces of all comparable engines and in addition a combined inlet and outlet passage.

The means for combating heat exchange are: First, jacketing; second, multiple expansion, and, third, superheating. Of those corrective means the Wolf engine makes the fullest use. Jacket heating is replaced by the more intense flue-gas heating; the highest possible superheating is used, and in addition multiple expansion. Furthermore, there is utilized in the most advantageous way the benefit resulting from the conservation of heat incident naturally to the union of the boiler and the engine. In this connection Mr. Heilmann says: "The use of the highest possible degree of superheating, from the standpoint of practical operation, seems advantageous with the compound engine." He should have added to his, "particularly with the Wolf compound engine." Sever the connection with the boiler, place the Wolf engine and the compound engine on foundations, and the dark sides of the former will be revealed at a glance.

It is an error to allege that superheating is economical in the case of a uniflow cylinder. To decide that question, nothing short of carefully conducted tests of engines absolutely fault-free in design and manufacture can be of value. An engine representing these conditions was the well known 300-horsepower Sulzer uniflow engine. This was provided with a cylinder jacket, but Mr. Heilmann's article gives a summary of results from such uniflow engines as were not so provided. Although he provided the compared compound "locomobile" with the extreme protection of flue-gas jacketing, he brings forward "uniflow" results where cylinder jackets were wanting and where there was a correspondingly greater steam consumption.

The results from the 300-horsepower Sulzer engine are evidently very uncomfortable for Mr. Heilmann and he seeks to get rid of them. During the numerous tests made at Winterthur, measurements of the condensate were taken, a method which, with reference to accuracy and reliability, excels that of measuring the feed water. In those tests there were charged against the engine the entrained water always carried over by saturated and often by superheated steam, and the water of condensation from the cylinder jackets and the head jackets; these latter two notwithstanding Mr. Heilmann's assertion to the contrary. The feed-water method is uncertain in the matter of reading the boiler-water levels. Different conditions of operation at the beginning and ending of the test also result in appreciable variations, and a skilful experimenter can give favorable or unfavorable results. In addition to the foregoing there are the unavoidable leakages of the stuffing boxes, valves, flanges and piping.

The firm of Burmeister & Wain, of Copenhagen, attained the results shown in Table 1 with an engine of 17.5 inches cylinder diameter and a stroke of 23.5 inches, running at 180 revolutions per minute.

This engine was without cylinder jacketing. The slight difference in comparison with the Sulzer engine results is easily accounted for by the different engine sizes and by lack of insulation due to the absence of cylinder jacketing. This is shown especially with saturated steam. In this engine, as with the Sulzer engine, the valves were absolutely tight. The steam consumption was determined by measuring the feed water. The poor mechanical efficiency is accounted for by the insecure mounting at the works for testing purposes.

A roll-driving uniflow engine built by Ehrhardt & Sehmer, having 24.5 inches cylinder diameter and 39 inches stroke, with a steam pressure of 140 pounds at a temperature of 376 degrees Fahrenheit, gave a steam consumption of 12.25 pounds per indicated horsepower-hour; a result which, considering the lack of cylinder jacketing, is again very close to the Sulzer results. Here too the feed water was measured.

A uniflow steam engine built by John Musgrave & Sons, Ltd., Bolton, England, gave a steam consumption of 10.85 pounds per indicated horsepower-hour with an initial pressure of 120 pounds, and a steam temperature of 490 degrees Fahrenheit. The steam consumption was determined by feed-water measurement, and again, bearing in mind the absence of cylinder jacketing, the results approach those of the Sulzer test. The same firm built another uniflow engine which, with an initial pressure of 162 pounds, a steam temperature of 518 degrees Fahrenheit, and a good vacuum, and without cylinder jacketing, showed a steam consumption per indicated horsepower-hour of 9.9 pounds.

* $\left(\frac{\text{Steam consumption in no-loss engine with incomplete expansion}}{\text{Steam consumption of the actual engine}}\right)$

It is an error to state that the uniflow engine has an unfavorable mechanical efficiency and that the high compression unfavorably influences the latter. High compression eliminates the pressure-direction change from the stroke reversal, makes the engine run smoothly, and through these results improves the mechanical efficiency.

However, as long as the gross load and the net load are the same, there cannot be any argument concerning the unfavorable influence of high compression on mechanical efficiency. In accord with this are the published tests at the Alsatian Machine Works Company, showing a mechanical efficiency of 92 per cent., a result which Mr. Heilmann conveniently overlooks. Similar, and in part better, results have since been given by many other uniflow engines. At present there is no uniflow engine in which the gross load exceeds the net load. Such indeed, however, is the case with many expansion engines. It is thus entirely wrong for Mr. Heilmann to consider the quotient:

$$\frac{\textit{Compression load}}{\textit{Indicated load} + \textit{compression load}}$$

as the coefficient of mechanical efficiency. Compression can serve to very much improve the mechanical efficiency by balancing, or evening up, the forces and by lessening the blow effect or pounding. The whole basis of the observations by Mr. Heilmann and the resultant conclusions are wrong and in direct contradiction of results. But particularly faulty is the conclusion that on account of the alleged poor mechanical efficiency, the economically favorable cutoff represents an average pressure of 44 pounds. With ample jacketing the favorable average pressure in the case of the 300-horsepower Sulzer uniflow engine was about 32.2 pounds, referred to the effective duty (see Fig. 1).

It is thus more than faulty when Mr. Heilmann, through his wholly wrong basic comparison, declares an efficiency of from 0.82 to 0.83 for an average pressure of 23.5 pounds. For example, Sulzer Brothers guarantee a steam consumption for a uniflow engine with a cylinder diameter of 33.5 inches and a stroke of 39.4 inches, with steam at a pressure of 176 pounds per square inch and a temperature of 572 degrees Fahrenheit, as follows:

With mean effective pressures of 11, 22, 33, 44 and 55 pounds per square inch and respective mechanical efficiencies of 0.88, 0.885, 0.92, 0.94 and, again, 0.94 corresponding steam consumptions in pounds per indicated horsepower-hour of 9.35, 9.35, 9.68, 10.12 and 11 per indicated horsepower-hour. These values agree with those shown by Fig. 1.

Noteworthy is the steam consumption with the mean effective pressure between 11 and 22 pounds, and for which Mr. Heilmann introduces a pressure of 44 pounds.

TABLE 1. DATA FROM BURMEISTER & WAIN TEST

Load			Pressure per Square Inch, Pounds	Temperature of Steam, Deg. F.	Vacuum, Inches of Mercury (Bar. 30")	Revolutions per Minute	Total Steam Consumption per Hour, Pounds	Hourly Steam Consumption, Pounds per		
Kilowatts	Effective Horsepower	Indicated Horsepower						Kilowatts	Effective Horsepower	Indicated Horsepower
64.50	97.7	114.8	140.5	666	28.2	179	1054	16.37	10.69	9.06
86.46	128.7	147.5	140.1	669	28.1	175	1390	16.10	10.69	9.28
108.66	161.4	183.6	139.7	667	28.0	176.5	1756	16.19	10.78	9.54
131.24	195.0	219.7	139.1	667	27.8	173.5	2149	16.39	10.93	9.68
109.00	162.0	184.0	138.4	dry sat.	27.9	178.	2531	23.21	15.46	13.64

The greatest friction losses are due to the piston and the stuffing-boxes, to the main bearings and in decreasing value to the other bearings. As the normal uniflow engine has but one piston and one stuffing-box as compared with two pistons and two stuffing-boxes for the Wolf engine, and as in addition the main bearings, owing to the lighter flywheel, are less heavily loaded, there cannot be any argument in favor of the superiority of the tandem engine with reference to mechanical efficiency. In order to figure out the most unfavorable piston pressures possible for the uniflow engine, in comparison with the tandem-compound engine, Mr. Heilmann takes a ratio of 1:4; something unknown in stationary steam engines.

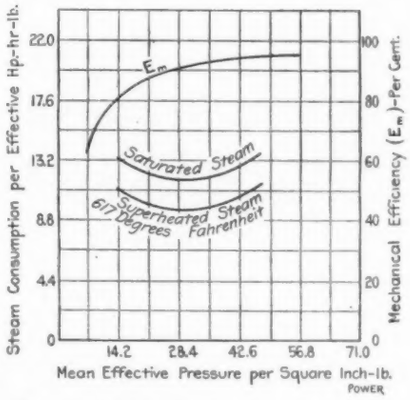


FIG. 1. RESULT WITH SULZER ENGINE

Mr. Heilmann holds that the high compression of the uniflow engine is a thermal fault, though such compression, with a good vacuum and a corresponding clearance, can be varied almost at will. He, however, considers himself justified in always compressing up to initial pressure in his high-pressure cylinder, something which never happens in the uniflow cylinder. Mr. Heilmann thus compresses higher in his reverse-flow cylinder than is done in uniflow engines, at the same time declaring that high compression in the latter is nonsensical and useless.

It is an error when Mr. Heilmann asserts that the uniflow engine is limited to a small total expansion. A glance at Fig. 1 shows that with good construction almost the same average pressure can be used as in the compound engine. The losses through throttling in the high-pressure discharge passages, the receiver, the low-pressure inlet and outlet, as well as the heat losses of the high-pressure cylinders and the receivers, disappear with the uniflow engine. As a result of these losses the compound diagram, running condensing, must be less complete than the uniflow diagram. Mr. Heilmann consoles himself with these losses being made good in the low-pressure cylinder. The plotting of an entropy diagram, however, shows that only one-third of such losses are recovered. The losses by radiation are appreciably larger in the compound engine than in the uniflow engine.

The investigation of the Wolf compound locomobile with saturated steam showed a cylinder efficiency of 73 per cent., and with superheated steam at 617 degrees Fahrenheit, a cylinder efficiency of 86 per cent.; both referred to a terminal pressure of 33 pounds absolute. The Sulzer uniflow engine with saturated steam gives a cylinder efficiency of 88 per cent., and with superheated steam at 617 degrees Fahrenheit a cylinder efficiency of 89 per cent., both values again referred to a terminal pressure of 33 pounds absolute. The cylinder efficiency includes the losses due to clearance, the thermal losses, the throttling losses and the losses through leakage.

In Fig. 2 are plotted the cylinder efficiencies (*Gütegrad*) of the 300-horsepower Sulzer uniflow engine as dependent upon the cutoff with saturated steam and with steam of 617 degrees Fahrenheit; in both cases steam jacketing being employed. In these efficiencies are considered the losses due to throttling, the thermal losses and those incident to leakage. These curves show the small effect of superheating.

In Fig. 3 are shown ideal steam-consumption values of a 300-horsepower uniflow engine, calculated with reference to the influence of clearance and using the cylinder efficiencies plotted in Fig. 2, but recalculated first for the steam pressures and temperatures of the Wolf tandem locomobile and second for the steam

pressures and temperatures of the Kerchove engine.

Particularly noticeable is the inferiority of the Wolf engine with saturated steam, whereas a striking superiority shown on the side of the uniflow engine is its minimum steam consumption under all practical steam temperatures. If the uniflow curves were recalculated for steam consumption, and if there were taken into consideration the use of the jacket condensate as feed water and the lesser oil consumption it would be found that the consumption curve would closely approach a horizontal line.

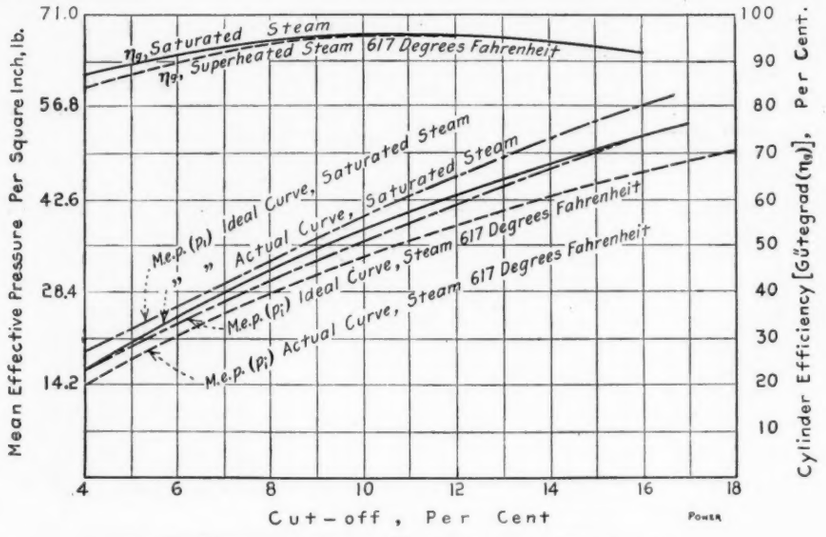


FIG. 2. EFFECT OF CUTOFF UPON CYLINDER EFFICIENCY

ages of the cylinder shown in that figure or in Fig. 8 (page 661, Oct. 31 issue of POWER) is very small.

Exhausting free, the cylinder represented by Fig. 8 is superior to that of Fig. 7 (same page) in that, by the latout 20 per cent. of the stroke, such surfaces in the ordinary steam engine being in constant contact with the live steam and, for 60 per cent. of the stroke, most concerned in heat transfer. Based on the observation in question as given in my original article and as shown by the diagram of Fig. 6 (page 661, Oct. 31 issue), it appears that the injurious effect of the walls of the exhaust pass-

TABLE 2. COMPARATIVE TESTS WITH FEED WATER MEASUREMENT AND CONDENSATE MEASUREMENT

	Horizontal Compound Engine	Horizontal Tandem Engine	Horizontal Compound Engine		Uniflow Engine					
Cylinder dimensions, inches	15 and 25x31	13 and 21x33	24 and 41x43		23x31					
Steam pressure, pounds	134	137	121	114	135	135	135	132	132	132
Steam temperature at the throttle, degrees Fahr.	358 (saturated)	578	592	657	317	509	358.5 (saturated)	572	500	357 (saturated)
Revolutions per minute	80.6	126.6	93.7	91.2	150	150	150	150	150	150
Indicated horsepower	137.3	217.5	456.4	703.9	..	all a	bout	237.6	..	..
Hourly steam consumption per effective horsepower-hour with:										
Feed-water measurement, pounds	15.48	10.45	10.73	10.86	..	..	..	9.68	10.29	12.36
Condensate measurement, pounds	14.60	9.79	9.74	10.20	8.82	9.50	10.60	..	..	..
Increased consumption with feed-water measurement in per cent	6	6.6	10	6.5	6.7	8.8	15.8	..	..	..
Jacket condensation in per cent	14	..	..	..	..	..	..	..	..	..

MR. HEILMANN'S REPLY

Regarding the objections raised by Professor Stumpf, I would reply as follows:

As proved by me in detail, the value of the uniflow design rests primarily on the surfaces of the exhaust passages being excluded from heat transfer throughter, the disadvantages of high compression with atmospheric exhaust are particularly noticeable. Comparative tests made by Professor Grassmann of two cylinders, which differed from the single cylinder only in the use by the latter of the uniflow and its consequent high compression ratio, showed with free exhaust an increased consumption by the uniflow cylinder of about 10 per cent. The assertion that the cylinder shown, Fig. 8, is afflicted with 40 per cent. of all the faults of the reverse-flow cylinder indicates a wholly superficial and unscientific manner of observation, misled by the term "uniflow" engine. The "uniflow" direction within the cylinder is unimportant as the flow velocity of the steam over the piston surfaces is low, and also because, leaving out the different velocities, the proportion of loss due to the cylinder is very small (V_3 +

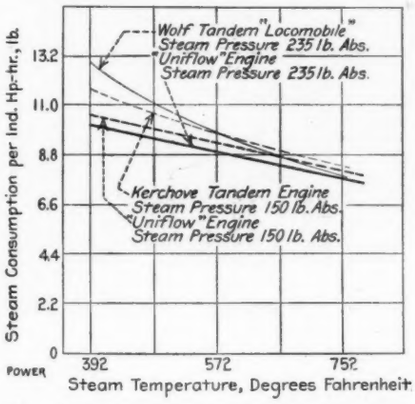


FIG. 3. COMPARATIVE STEAM CONSUMPTION OF WOLF LOCOMOBILE, KERCHOVE AND WOLF UNIFLOW ENGINES

V_3 in the diagram of Fig. 6 of my article).

The heat utilizations of the investigated compound engine, the uniflow engine with shallow piston and without jacketed heads, and the uniflow engine of Professor Stumpf's design were considered by me separately. Professor Stumpf seeks to present the subject as though I had merely compared the results from the uniflow cylinder of the type shown in Fig. 8 with the results from the best compound engine, which is entirely incorrect.

With reference to the cylinder shown in Fig. 8 I stated that it was constructed for high superheat and for that reason was wholly unprovided with any jacket heating, and that the tests with saturated steam and moderate superheating were made only in the interest of science.

When Professor Stumpf says further that in the cylinder, as shown by Fig. 8, "through the introduction in the exhaust area of a choking release valve and the omission of all heating, everything has been done to obtain the worst possible results," it is sufficiently evident that his intent is to depreciate the purpose and value of the tests. I would say that the loss through throttling effect in the exhaust passage and in the operating valve for this cylinder has so far not been 1 per cent.

The advantages of the locomobile design are expressed in fuel consumption much more than in steam consumption. Professor Josse says: "In the locomo-

bile the piping losses and the heat losses through condensation disappear; hence the superiority of the locomobile over stationary installations as regards economy." An advantage of the locomobile is the possibility of intermediate superheating by means of the waste gases at almost no cost. For that reason I brought under consideration only tests made without intermediate superheating for comparison with stationary engines.

Thermally considered there is no connection between the boiler and the engine. With steam at a pressure of 220 pounds and a temperature between 644 and 662 degrees Fahrenheit, the steam consumption, as an average of several tests and with different loads, amounted to 8.25 pounds per indicated horsepower-hour and 8.8 pounds per effective horsepower-hour. The fuel consumption amounted on the average to 0.97 pound with feed-water heating by the waste gases.

In the use of highly superheated steam and compounding it has been proved that the simple slide-valve engine, even with less favorable proportions in the matter of detrimental surfaces, approaches in its results the most complicated poppet-valve engine.

The value of the so-called uniflow design I did not question; quite the reverse, I proved it in detail. I did dispute that with the uniflow design compounding and superheating became superfluous. I agree throughout with Mr. Stumpf that for the deciding of this question only carefully carried out tests can be of value. I would add that the details of tests must be included insofar as they are necessary for the determination of all relationships. The tests on which Professor Stumpf bases his deductions do not represent the contention at issue. It is not right if tests with the condensate-measuring method are compared, without further investigation, with the feed-water-measuring method. It is not with the latter method but by the former that a skilful investigator can at will determine very favorable results. This would apply particularly with the jacketed reciprocating steam engine; much less so with the steam turbine. Table 2 shows the differences as determined between feed-water measuring and condensate-measuring methods with reciprocating engines. It appears therefrom that the differences are larger as the load is smaller. The much greater difference determined for the uniflow engine with saturated steam cannot be explained by greater leakage but only by the jacket condensation, particularly noticeable with saturated steam, flowing back through the piping and remaining unaccounted for.

In the engine tests by Burmeister & Wain (compare with Table 3), the average mean effective pressure was somewhere between 3.3 and 6.6 pounds. Only during the last three tests was there an approximation toward normal loading. The mechanical efficiency was about 89 per cent. The consumption figures at normal loading correspond closely with my curve of comparison for the uniflow engine. The increased consumption with saturated steam as compared with steam at 662 degrees Fahrenheit amounts to about 40 per cent., a proof that with this engine superheating is in no way superfluous. Referring to the uniflow engine of Ehrhardt & Sehmer of 24.5 inches cylinder diameter and 39 inches stroke, there are wanting both the load and the mean effective pressure.

In the comparison of different engines for economy, tests made under conditions of their nominal loading should be chosen. Comparison on any other basis I declare to be wrong.

A striking proof of the correctness of my assertion that for economy comparison tests made under nominal load conditions should be used, and that a mean effective pressure of about 44 pounds is to be considered as suitable for the uniflow engine is furnished by the calculations for steam and heat consumptions for the effective horsepower of the Sulzer engine, based on the statements of Professor Stumpf (see Table 3). The steam consumption per indicated horsepower-hour with a mean effective pressure of 1.7 pounds is, as is evident, entirely worthless for determination. A comparison with the heat consumption of the Wolf compound engine tested by Professor Doerfel shows the high value of compounding as favoring the use of high steam pressures and temperatures.

Mechanical efficiency is primarily dependent upon the proportions of the driving mechanism, and under certain circumstances compression is of high significance.

As the uniflow engine, on account of the greater stresses in its driving mechanism, requires a heavier shaft, and as the piston friction is undoubtedly higher, the lesser mechanical efficiency of the uniflow engine is sufficiently proved, being, from the foregoing tests, not over 90 to 91 per cent. As far as it was possible, I calculated the mechanical efficiencies shown by the tests included in Professor Stumpf's book "The Uniflow Steam Engine." Particularly noteworthy is the low mechanical efficiency of the uniflow engine with free exhaust. The assertion that I conveniently overlooked the 92.5 per cent. efficiency of the Alsation Machine Works' engine is incorrect; but I did overlook that this efficiency is understood as excluding the need for condensing and that when including it the efficiency drops to 89 per cent.

Lorenz, in *Zeitschrift* for 1894, page 1267, stated and proved that for a given indicated load of an engine the mechanical efficiency becomes smaller the greater the compression. In other words, the mechanical efficiency grows smaller the greater the ratio:

$$\frac{Nc}{Ni + Ne} \qquad (1)$$

chosen by me to represent the results of the tests, and in which

Nc = Compression load or work absorbed by compression;

Ni = Indicated load;

Ne = Effective load.

The noticeable fact that the friction load with increasing ratio (1) rapidly augments while the indicated load falls off, leaves no doubt as to the significant influence of compression.

The remark of Mr. Stumpf, "In order to figure out the most unfavorable piston pressures possible for the uniflow engine, in comparison with the tandem-compound engine, Mr. Heilmann takes a ratio of 1:4, something unknown in stationary steam engines," indicates another attempt to depreciate the value of my demonstrations. The cylinder ratio of 1:4 is the rule for the Wolf locomobile with superheat, and hence there was no arbitrary assumption.

High compression in the high-pressure cylinder of a compound engine is neither thermally nor mechanically disadvantageous to the extent that it is in the uniflow engine because the compression path is very short and because the volume at cutoff in the high-pressure cylinder is relatively large. In spite of high compression in its high-pressure cylinder and its further inferiority, as alleged by Mr. Stumpf, the total efficiency of the Wolf engine even with entirely normal construction with a simple piston valve is far better than that of the uniflow engine.

TABLE 3. STEAM AND HEAT CONSUMPTIONS OF THE SULZER UNIFLOW ENGINE PER EFFECTIVE HORSEPOWER-HOUR, CALCULATED FROM THE STATEMENTS OF PROFESSOR STUMPF

Mean effective pressures, pounds per square inch	11	22	33	44	55
Steam consumption per effective horsepower-hour, pounds	12.1	10.56	10.56	10.78	11.66
Heat consumption per effective horsepower-hour, B.t.u.	15,872	13,848	13,848	14,166	15,316
Heat consumption per effective horsepower-hour of the Wolf compound engine tested by Professor Doerfel, B.t.u.	10,884				

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

An Analysis of Some Recent Gas Engine Failures

By Howard S. Knowlton

Increasing experience with gas engines in power plants operating in many localities and under widely varying conditions is doing much to indicate and correct weak spots in design and service performance. In the following notes, drawn from an insurance engineer's report, are given the main facts in connection with a number of recent gas-engine breakdowns, the material being gathered in actual power-plant practice by the technical staff of a large company underwriting machinery of this kind against failure.

The first failure occurred with an engine using illuminating gas. The trouble was due to a makeshift method of protecting the attendants in the station from an overhanging flywheel carried on the crank shaft. The protection was attempted by providing a guard having a central hole through which one end of the shaft projected. For some reason, this guard had sagged sufficiently to rest upon the shaft, and to prevent contact it had been raised and held up by a weight at the end of a rope passing over a block hung from a beam over the engine. After a while the rope broke and the weight fell into the crank space, where it was caught and driven through the bedplate by the large end of the connecting rod. The bedplate was cracked in three directions from the hole and the connecting rod was bent.

Another breakage occurred to an 11x19-inch gas engine nine years old, running at 200 revolutions per minute. Attention was drawn to the defective condition by a violent blowing through the piston at each explosion in the cylinder. The engine was at once stopped, and when an inpector was called, the piston was withdrawn, and a hole about 2x½ inches was found in the end. On taking out the connecting rod the hole was found to have been caused by a setscrew used to hold the rear brass in the small end of the rod. This screw had worked loose and come out; its head had been broken off and had worn a hole nearly through the end of the piston, and finally had been driven through the remaining thickness of metal.

An interesting case of bolt failure occurred in a 20x30-inch horizontal gas engine running at 160 revolutions per minute and developing an initial pressure on the piston of about 375 pounds per square inch. The cap at the larger end of the connecting rod was secured by two bolts of the dimensions shown in Fig. 1. Two sets of bolts were kept, each set being used alternately for periods of 6 months, and then annealed. When near the end of its third run, the upper of the two bolts broke close to the head through a $\frac{5}{16}$-inch hole drilled for securing a feather key for preventing the bolt from turning when the nut was being screwed up. The other bolt was bent, drawn down to a diameter of 1½ inches, and broken at *a* and *b*. The piston, cylinder, cylinder liner and water connections to the jacket and piston were broken and the connecting rod bent. The fracture at *a* appeared to have started at the feather key and worked its way gradually through the bolt, as the final break covered a very small area, about 1x$\frac{5}{16}$ inch. The cap of the connecting rod was indented by the heads of the bolts, the upper one penetrating about $\frac{1}{16}$ inch, and the lower one $\frac{1}{32}$ inch. The butt end of the rod was also scored by the nuts, indicating that at some time the bolts on the other pair had been allowed to work with the nuts slack. It was not ascertained whether this or too high a temperature in the annealing furnace caused the failure.

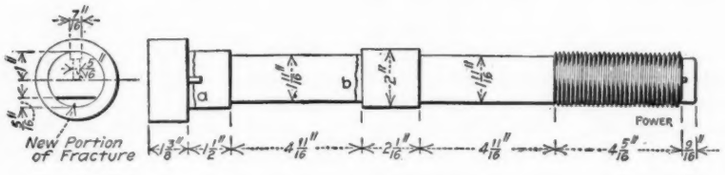


Fig. 1. Fractured Bolt

Wear and tear and the working of the engine under adverse conditions caused a break in a 20x24-inch engine running at 160 revolutions per minute. Gas was supplied from the city mains. The water used for cooling the cylinder jacket was insufficient in quantity and heavily impregnated with lime. This led to the overheating of the cylinder and its subsequent fracturing at the end, the second fracture in eight years. The discharge from the cylinder jackets should never have been allowed to rise above 120 degrees Fahrenheit, and proper facilities should have been provided for removing deposit from the heated surfaces and narrow passages over and through which the cooling water circulates. Not a few gas-engine troubles are due to this neglect of the cooling-water conditions and service.

Fig. 2 illustrates a crank shaft which failed between the flywheel and the crank bearing. The engine was of the horizontal type, nine years old, with a 6¾x15-inch cylinder; the speed was 200 revolutions per minute. Illuminating gas was the fuel. The engine had one flywheel weighing about 800 pounds. The shaft broke in the bearing, the fracture extending practically into the keyway. It was estimated that the engine had made 288,000,000 revolutions and about 50,000,000 explosion strokes. The engineering staff of the insurance company figured that assuming an initial pressure of 300 pounds per square inch on the piston, the stress on the neck would be about 21,000 pounds per square inch. The stresses were calculated on the supposition that all pressures and reactions act through the middle points of the bearings to which they are applied. It appeared that the cause of the break was weakness. In order to reduce the stress to the lower point of 9000 pounds per square inch, the diameter of the shaft would have had to be 3⅜ inches instead of 2½ inches. A most singular phase of the failure was the fact that the shaft of another engine over 100 miles away, of the same make, and bearing the next consecutive shop number broke on the same day and in the corresponding bearing.

Another shaft failure occurred in a 12x18-inch engine running at 160 revolutions per minute. The crank shaft was supported by two bearings and carried two overhanging flywheels, as indicated in

Fig. 1. The shaft broke through the left-hand neck close to the crank, and was also found cracked half-way through the right-hand neck. The stress was low in this case, only about 8500 pounds per square inch, but there were practically no fillets at the junctions of the necks with the crank webs. The engine had made about 288,000,000 revolutions and carried about 72,000,000 explosion strokes prior to the accident.

The next case was a horizontal gas engine, about 18 months old, having an 18½x24-inch cylinder, running at 160 revolutions per minute on suction producer gas. The exhaust pipe, 8 inches in diameter and ¾ inch thick, was vertical 14 inches from the bottom of the breech end and then ran horizontally for 9 feet in a trench to a connection with a muffler. The latter was of unusual weight on account of an addition erected on top of the original box. The latter rested on two iron rollers ⅝ inch in diameter, which in turn rested on the concrete bottom of the trench. The distance from the back of the muffler to the end wall of the trench was 2 inches. The exhaust pipe cracked circumferentially close to the flange by which it was attached to the breech end of the cylinder, and on the side facing the muffler.

Subsequent examination disclosed that the concrete under the muffler had been softened by oil and water and the rollers had sunk into it. The exhaust pipe was therefore exposed to the sum of two stresses, one the frictional resistance of the muffler sliding on the concrete instead of moving on the rollers, and that from the bending moment produced from the settlement of the rollers and muffler. The first would be of little account unless something lodged between the muffler and the end wall of the trench; the second, measured in pounds per square inch, would be three times the weight of the muffler and discharge pipe leading from it into the air, except as modified by the elasticity of the bottom of the breech end and of the joint between it and the pipe. This weight was not determined, but it would not have had to be large in order to cause the fracture, since the internal surface of the pipe had been exposed to a temperature corresponding closely to red heat. If the rollers carrying the muffler had been laid on an iron plate, and more space left between the muffler and the wall, little, if any, trouble would have been encountered.

Defective lubrication caused another representative failure. The engine was of the horizontal type, 11x21 inches, running at 180 revolutions per minute on illuminating gas. The valve-gear shaft was driven from the crank shaft by a pair of wheels and ran alongside the engine frame. The caps of the bearings for the lay shaft contained oil boxes closed by lids. The bearing next to the crank shaft was located between the flywheel and the engine frame, and not easily accessible while the engine was running. The bearing became hot and seized through lack of oil, and the bracket carrying it, as well as the driving wheels for the lay shaft, were broken. It was pointed out in the report of the engineer of the casualty company that the lubrication of the lay shaft is a weak point in many gas engines. The arrangement in this case was particularly bad, since the attendant could not see whether the oil box was full or empty while the engine was running. Conditions would have been much improved by the use of a glass lubricating gage, although better results would have been obtained with ring lubrication.

Another case of interest was that of an 11x17-inch engine, running at 190 revolutions per minute on illuminating gas. The cylinder jacket was cast with the breech end, the liner and engine frame being in separate castings. The liner at the rear end abutted against a faced surface in the breech end and at the front end against a similar surface on the end of the frame. When the flange at the front of the jacket was tightened against the frame the liner could expand only by breaking or stretching the bolts by which the frame and jacket were held together, by tearing off the jacket or breaking the latter circumferentially. In this case the bolts were broken and the jacket was saved. The accident emphasized the fact that proper allowance for the expansion of a liner for a gas-engine cylinder is absolutely essential.

A poor arrangement of air intakes was responsible for no little trouble in an 8½x15-inch engine running at 160 revolutions per minute on illuminating gas. The air for the cylinder charges was drawn through the interior of the bedplate, to which it was admitted by slots in the side. The arrangement was clearly hazardous. It was pointed out in the report of the accident that if by any means, such as leakage past a slightly open gas cock, gas should be forced into the cylinder during a stoppage of the engine, and if the engine should be stopped

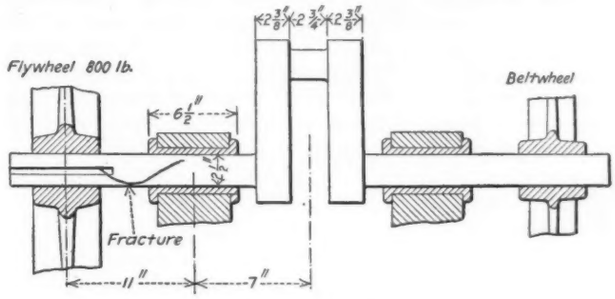


FIG. 2.

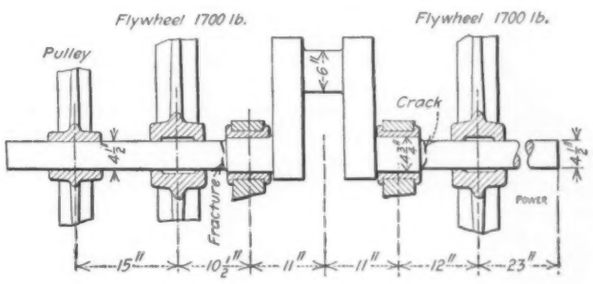


FIG. 3.

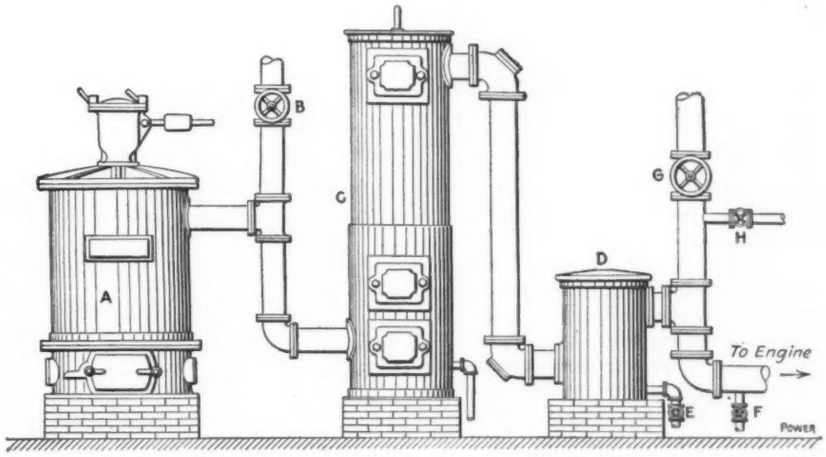


FIG. 4. GENERAL ARRANGEMENT OF PRODUCER PLANT

with the exhaust valve open, the space inside the bed would be filled with a combustible mixture of gas and air which might easily be ignited in starting. Something of this character evidently occurred in the above case. On restarting, an explosion occurred inside the bedplate. The latter and a large casting on which it stood were damaged beyond repair, all the flywheel arms broken and the rims detached from them, besides minor injuries.

Fig. 4 shows the arrangement of a gas-engine installation in which a bad explosion occurred in the expansion box outside the engine. The plant was of the suction-producer type, comprising a generator *A*, a purge pipe and cock *B*, a wet scrubber *C* and expansion box *D;* there were also two ¼-inch unsealed drains *E* and *F*, an escape pipe *G* and testing tap *H*. The engine was shut down for the end of the week one evening, the valves in *B* and *G* being left shut and the drains *E* and *F* open. On the next day the generator was cleaned out, and on the second morning, which was Sunday, the fire was lighted, the cock *B* opened and the drain cocks shut. About 2:30 p.m., an explosion occurred and the top of the expansion box *D* was blown off. The explanation of the accident given in the report was as follows:

As soon as the drains *E* and *F* were opened, air had access to the expansion box *D*, and when the fire was burned down and the generator cleaned out, to the scrubber also. Thus explosive mixtures, probably of different strengths, were formed in each, and ignition, followed by explosion, occurred as soon as the fire when rekindled had burned through sufficiently to send a spark or flame into the pipe leading to the scrubber. At the time of the explosion the fire in the generator was probably burning more fiercely than usual, on account of a strong wind which was blowing. If the drains *E* and *F* had been sealed by water, air could not have entered the expansion box through them; if the pipe entering the scrubber from the generator had been water sealed, air could not have backed into the scrubber; if there had been a two-way valve at the junction of the generator delivery pipe with the purge pipe, allowing alternative connection between the generator and the purge pipe or the generator and the scrubber only, air could not have entered the scrubber even if there had been no water seal at the bottom of the latter.

On the advice of the insurance interests the water seals and the two-way cock mentioned were installed. In spite of this a few months later the cover of the expansion box was blown off again. The explosion occurred soon after starting the engine, after it had been standing for four days, the cause in this case being a bad joint between the expansion box and its cover, through which air entered the box and diluted the gas inside. Before starting the engine the two-way valve substituted for the valve *B* on the diagram was opened from the generator to the atmosphere, and the fan used until the gas appeared at a test cock (not shown on the diagram) between the generator and the scrubber. The two-way valve was then turned to place the generator in communication with the scrubber, and the engine was started with illuminating gas. As soon as it was in motion the illuminating gas was cut off and the valve between the engine and the expansion box *D* opened, admitting to the cylinder the diluted but explosive gas, which burned slowly and remained lighted until the gas valve opened to admit the next charge. This charge was ignited while the admission valve was still open, and the flame ran back into the expansion box, which, owing to the leaky joint above mentioned, was filled with an explosive mixture of gas and air. If the attendant had opened the valve *G* and kept the fan working until undiluted gas was obtained at the test cock *H* the explosion would have been avoided.

The freezing of water in a jacket caused a failure in the case of an 8x15-inch horizontal engine 14 years old, run on illuminating gas. The engine was located in an outbuilding in which a gas jet was supposed to be lighted during cold nights, and the cylinder jacket was provided with a drain through which it could be emptied. The jacket was found split longitudinally from end to end after a Sunday shutdown, and the breech end was also cracked both longitudinally and transversely. The trouble was clearly due to the expansion of the water in the jacket at the moment of freezing. The danger of leaving jackets full of water and engine rooms unheated has often been emphasized by accidents of this character.

The Bogert Auxiliary Heater

It has long been recognized by gas-engine designers that the temperature of the exhaust gases is sufficiently high to be used for the purpose of heating. In England, a considerable business is done at the present time with a horizontal type of tubular boiler through the tubes of which the exhaust gases pass on their way to the atmosphere. It is said that this boiler generates from 2½ to 3 pounds of steam at 60 pounds pressure per brake horsepower-hour when the engines are operating at nearly full load.

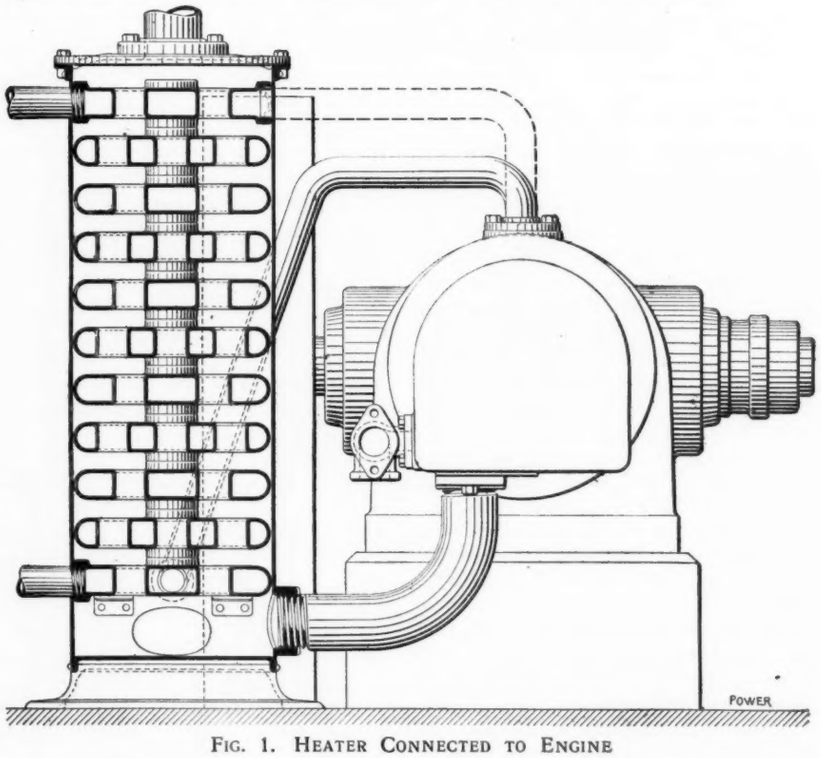


FIG. 1. HEATER CONNECTED TO ENGINE

A serious drawback in boilers "fired" with exhaust gases and made wholly of steel or wrought iron is that the metal suffers corrosion when coal containing sulphur is used, resulting in rapid deterioration. To meet this objection, John L. Bogert, consulting engineer of the New York Engine Company, some time ago designed a cast-iron sectional boiler, which embodies several interesting features. Fig. 1 shows a vertical section of one of these boilers, having 11 sections or elements. Fig. 2 shows a plan view of half of one of the elements and a vertical section of two of them, from which the method of building up the heater can be readily gathered.

The shell is of steel plate, but it is lined

with ordinary brick, standing on end, for the purpose of confining the heat and also preserving the shell from corrosion. The gases pass through the shell

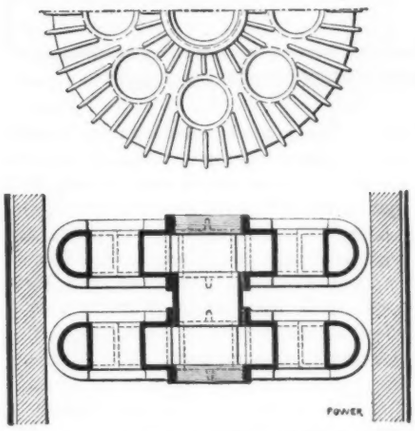


FIG. 2. DETAIL CONSTRUCTION OF ELEMENTS

outside of the cast-iron sections and the water is contained within the sections. The sections or elements are connected by threaded pipe nipples and the holes through the elements are staggered. The outside surfaces of the elements are ribbed to increase their heating surface, as indicated in the plan view in Fig. 2. The heater serves also as a silencer, the gases being allowed to expand in successive efforts, between the cast-iron elements, somewhat as in the Maxim silencer for firearms.

The compactness of this apparatus is illustrated by Fig. 3, which is a view of a power installation of two suction producer-gas engines, of 50 brake horsepower each, discharging their exhaust through one Bogert heater. The jacket water is fed from the jacket of the engine into the top section of the heater, and passes out through the pipe at the bottom. In this direction of flow of the water the hottest water comes in contact with the hottest gas and the coolest in contact with the coolest. The two engines here shown constitute the power plant for the boiler shop of the New York Engine Company, and they also drive a two-stage compressor which furnishes compressed air for the whole plant. The engine cylinders are 15 inches bore by 21 inches stroke, with crank shafts coupled to a common shaft carrying a flywheel and driving pulley, and they run at 200 r.p.m. The heater shell is less than 30 inches in diameter.

The power plant runs usually 10 hours a day. The temperature of the water in passing through the jackets of the engines is raised from 65 degrees to 130 degrees, Fahrenheit, and the exhaust heater raises it from 130 to 200 degrees. In the summertime it is not necessary to pass any water through the heater, and it is run bone dry, apparently without any ill effects.

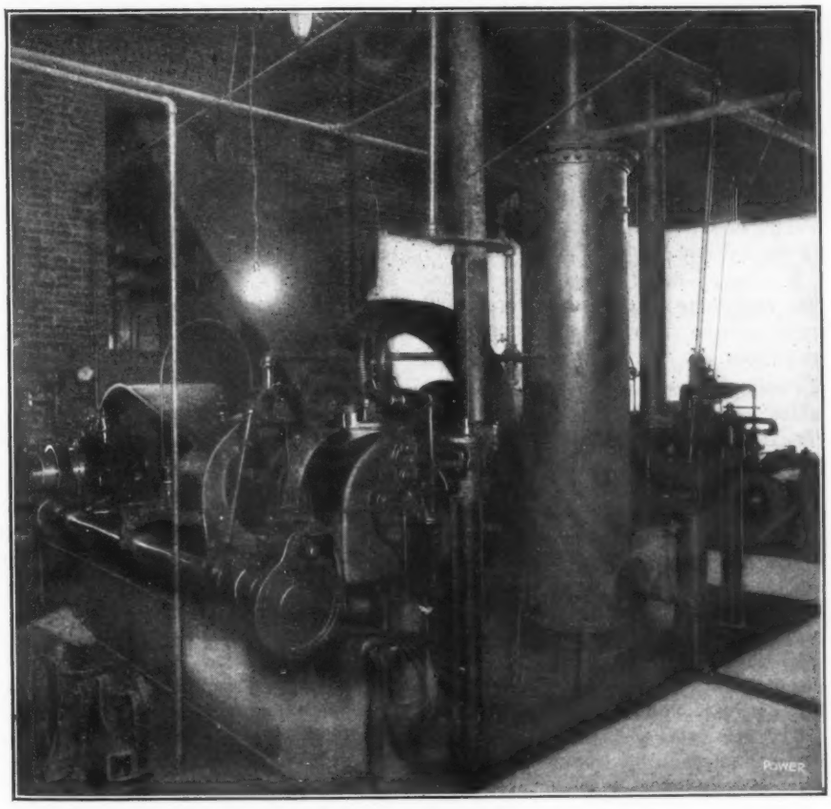


FIG. 3. A 100-HP. TWIN ENGINE WITH HEATER

Gas Power in a Manufacturing Establishment

At the recent meeting of the National Gas Engine Association, William Weber related his experience with gas power in the plant of the Van Dorn & Dutton Co., manufacturer of commutators and gears. The power plant consists of a three-cylinder 175-hp. engine coupled to a 150-kw. alternator and a four-cylinder 135-hp. engine belted to a jackshaft from which two lineshafts are belt-driven.

The larger engine has been in use three and a half years and the smaller one a little over two years. Both run on natural gas costing 30c. per 1000 cu.ft. The larger engine carries full load and the smaller one about 80 hp. The average monthly expense is given in the following table:

	Large Engine	Small Engine	Both
Gas @ 30c.	$101.25	$66.00	$167.25
Oil @ 20c.	9.00	8.00	17.00
Waste @ 9c.	0.90	1.08	1.98
Engineer	.....	.....	95.00
Helper (18 hr. per month @ 18½c.)	.....	.....	3.33
			$284.56

Mr. Weber is the engineer of the plant. He also has charge of a stockroom next to the engine room and looks after the 22 motors used in the factory, the lighting, wiring, etc. His duties outside the engine room occupy about half of his time.

The plant shuts down at 11:30 a.m. on Saturdays and the helper's services are then called into play; the engineer and helper go over the engines, taking off the crank-case covers, examining the bearings, trying all bolts and nuts to see if they are tight, etc. One exhaust and one intake valve-cage, with valves, are taken out of each engine, cleaned and, if necessary, ground, and put back in place. Each successive Saturday the valves of another cylinder are taken out and given the same treatment. Therefore, all of the valves of the three-cylinder engine get thorough attention once every three weeks, and those of the four-cylinder engine once every four weeks.

All spark plugs and igniters are changed once a week. The mixing valve is taken out and cleaned once a month on each engine.

Once a week ten gallons of oil are drawn from the crank case of each engine and replaced by fresh oil.

Every six months all of the oil is withdrawn from the crank cases, the cases thoroughly cleaned and then refilled with fresh oil. The oil taken out of the crank cases is used in some of the gear-cutters, mixed with screw-cutting oil, effecting a slight saving.

A thermometer is kept in the jacket-water outlet and another one is applied to the walls of the cylinders next to the crank cases, to keep posted as to the heat there.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

The Nonprecipitation of Calcium Chloride from Brine by Ammonia*

At the October meeting of the American Society of Refrigerating Engineers, in St. Louis, the question was brought up as to the effect of ammonia leaks on calcium-chloride brines. Statements were made at that time that in several instances where ammonia had leaked into calcium-chloride brine the calcium had been precipitated out of solution by the action of the ammonia. This precipitate was said to have been of a pasty nature and was therefore with difficulty removed from the brine tanks in which it formed.

It was the author's opinion that calcium chloride would not be precipitated in this manner and that the brine in question must have contained magnesium chloride as well as calcium chloride. Also, that calcium chloride would not be precipitated out of solution by ammonia unless carbon-dioxide gas was present in some form. To learn the exact cause of this precipitation the author has since carried out some interesting tests, the results of which are herewith presented.

The first brine treated with ammonia was made up with chemically pure calcium chloride. It was of 1.2 specific gravity. No precipitate formed for a long time and even after a long period this precipitate was very slight. If all air could be excluded and, consequently, all carbon-dioxide gas, there would be no precipitate at all under these conditions. The precipitate which does form is due to a slight carbonation of the calcium in solution.

The second brine treated with ammonia was made up with chemically pure magnesium chloride and was of 1.2 specific gravity. There was an immediate precipitation in this brine, the precipitate becoming heavier as the ammonia was passed in. The brine being made from chemically pure magnesium chloride, nothing else than magnesium can in any way be precipitated from such a solution. As a matter of fact, this is just what happened, the precipitate being magnesium hydroxide.

The third brine treated with ammonia was made up with equal parts of the two brines which had been already demonstrated; that is, one-half calcium chloride and one-half magnesium chloride by volume, of the respective chemically pure brines. On passing ammonia into this composite or mixed-chloride brine there was an immediate precipitation similar to that previously noted in the case of the chemically pure magnesium-chloride brine. As a matter of fact, the two precipitates were the same in composition, namely, magnesium hydroxide. There would also be a slight precipitation of the calcium due to the carbonation of a small amount of the calcium in solution.

The three experiments show that calcium chloride is not precipitated out of solution by ammonia, but magnesium chloride is precipitated. Also, that from a mixed-chloride brine the magnesium is readily precipitated by ammonia, whereas the calcium is not.

It is very evident that a calcium chloride containing magnesium chloride will make a brine from which ammonia will precipitate the magnesium.

Passing on to the commercial chlorides which are to be obtained on the market for refrigerating purposes, the fourth brine which was treated with ammonia was made up with a commercial chloride containing 74 per cent. calcium chloride and 1 per cent. sodium chloride. It was of 1.2 specific gravity. On passing ammonia into this brine there was no precipitate for a long time. After considerable time there was a slight precipitation of the calcium due to carbonation as was the case with the chemically pure calcium-chloride brine.

The fifth brine to be treated with ammonia was made up from a commercial chloride containing 57.62 per cent. calcium chloride, 9.31 per cent. magnesium chloride and 1.38 per cent. sodium chloride. Its specific gravity was 1.2. An immediate precipitation took place when ammonia was passed into this brine, exactly as was the case with the mixed-chloride brine made up with chemically pure chlorides and also in the case of the chemically pure magnesium-chloride brine. This precipitate became heavier as the ammonia was passed in and, as in the previous cases, was magnesium hydroxide.

The two commercial brines tested are typical of the two classes of brine in common use in this country, and their behavior in these tests is characteristic of all brines made up with such chlorides as have been used. The chlorides on the market vary to some extent in chemical composition, but not enough to form a third class.

It can be safely concluded therefore that the behavior of these brines which have just been tested is typical of all brines made up with commercial chlorides. When a calcium chloride contains magnesium-chloride impurity it will make a brine from which ammonia will invariably precipitate the magnesium out of solution. This means that with such a brine there will always be the danger that with ammonia leaks the precipitation spoken of at St. Louis will occur.

The reaction which goes on when magnesium chloride is precipitated out of solution as magnesium hydroxide is a variable independent of the conditions of temperature, pressure, etc. At times 50 per cent. of the magnesium in solution is precipitated out of solution. At other times as high as 97.5 per cent. can be precipitated out by the addition of ammonia.

Quantitative Experiments

In these quantitative experiments 250 c.c. of the respective brines were used in each case. The ammonia was passed in by distillation from aqua ammonia of 0.9 specific gravity.

In the sixth test the brine was made up with a chloride containing 57.62 per cent. calcium chloride, 9.31 per cent. magnesium chloride and 1.38 per cent. sodium chloride. It was of 1.2 specific gravity and 250 c.c. of this brine contained 8.13 grams of magnesium chloride. In a series of six tests fully 97.5 per cent. of the total magnesium chloride was precipitated out of solution by the addition of ammonia.

It is well at this time to point out the fact that the brine resulting after precipitating out the magnesium chloride, being so weakened in chloride content, must possess a decidedly higher freezing point than did the original brine. There is the possibility, therefore, that not only will there be danger of plugging up piping, etc., with the precipitated

*Abstract of paper read by Morgan B. Smith before the American Society of Refrigerating Engineers, New York, Dec. 4.

magnesium hydroxide, but there will also be the additional danger that the brine will freeze, if not solid, at least into a thickly congealed mass.

In the seventh test, brine was made up from a chloride containing 74 per cent. calcium chloride and 1 per cent. sodium chloride. It was of 1.2 specific gravity. Ammonia was passed into this brine in varying proportions with the same results, as noted above, with similar brine, namely, a very slight precipitate due to carbonation of the calcium in solution.

Some of these tests were carried through out of contact with the air, with the result that no precipitate whatever appeared. When, however, this brine, saturated as it was with ammonia, was exposed to the air for some time the characteristic precipitate due to carbonation of the calcium in solution appeared.

In order that some definite idea might be had of the extremely small amount of this precipitate due to carbonation, an experiment was carried through in which 750 c.c. of this brine containing no magnesium chloride was treated with ammonia distilled from 200 c.c. aqua of 0.9 specific gravity. The resulting solution, pretty well saturated with ammonia, was then allowed to stand in a shallow 12-in. dish giving a large surface exposed to the air. Under such conditions, which were very severe, in an atmosphere containing carbon dioxide in excess of normal, a precipitate did appear after 12 hours. This precipitate weighed 0.0150 gram per 250 c.c., the basis of the former experiments.

When this extremely small precipitate is compared with that formed under the same conditions with the brine containing magnesium chloride, namely, 4.76 grams $Mg(OH)_2$, equivalent to 7.80 grams $MgCl_2$, it is seen at once that this secondary precipitation due to carbonation is an entirely negligible quantity.

It would be advisable for all who operate refrigerating plants using calcium chloride to acquaint themselves with the true nature of the chloride which they purchase. A competent chemist can always tell when magnesium chloride is present and can help to avoid such difficulties as have been met with in the use of chlorides containing magnesium chloride as well as calcium chloride.

Calcium chloride itself is a very valuable material for use in refrigerating plants and, if used intelligently, will give excellent results. Calcium chloride, if contaminated with magnesium chloride, will be sure to cause trouble with ammonia leaks.

Many of these chlorides are called calcium chlorides. A better name would be composite or mixed chlorides, or better still, calcium-magnesium chlorides, which would then describe their true nature.

Operating Ammonia Compressors by Aid of Thermometers*

In the competent handling of a refrigeration plant there are some points which, if properly taken care of, may avoid trouble and in any event will be only beneficial.

No matter how well constructed, the plant is at the mercy of the operating engineer; it is a success or a failure according to his knowledge. If the plant's performance is not satisfactory to its owner, who mostly relies on his engineer, the owner usually demands that a test be made as to capacity, etc.

Then the manufacturer sends his men to insert thermometer wells in the suction and discharge pipes near the compressor and at other places where the reading of temperatures is of any importance. Preliminary to and during the test the temperatures of the suction and the discharge gas are carefully taken at frequent intervals as the manufacturer regards it of great importance in getting the best results; indicator diagrams are also taken to make sure that the valves are working properly or a piston is tight, and that the back pressure is so regulated as to be most suitable for this particular plant.

If this temperature is so important to the manufacturer, it is just as important to the owner; the closer he can run his plant to test conditions, the better are his results. How often is the suction-gas temperature taken by the operating man, and is he in a position to draw the proper conclusions and provide remedies if needed?

In the speaker's own experience in a fairly large plant the operating engineer was as good as the average, but it was found that the ammonia suction gas was superheated 31 deg. The suction pipe was not covered and the engineers were careful not to allow frost to enter the compressors, knowing that it caused leakage around the stuffing-boxes.

Assume, for illustration, that the compressor was a 16x24-in. single-acting machine, running at 78 r.p.m., with a back pressure of 15.67 lb. The temperature corresponding to the back pressure equals 0 deg. F.; the specific volume or volume of one pound equals 9 cu.ft. and the displacement of the compressor in cubic feet per minute equals 435.

Assuming 100 per cent. volumetric efficiency, the displacement divided by the specific volume corresponding to the back pressure results in

$$435 \div 9 = 48.33 \textit{ lb.}$$

that is, the pounds this compressor would deliver if there were no losses of any kind. Now, assuming a superheat of 31 deg. F., the ammonia entering the compressor at 31 deg. (instead of 0 deg., corresponding to the back pressure), the question is, how much less is the volumetric efficiency?

For each 1 deg. F. increase of temperature, and a back pressure of 15.67 lb. gage, the volume will increase 0.022 cu.ft. Consequently, for 31 deg. F., the increase will be

$$0.022 \times 31 = 0.682$$

Therefore the volume, instead of 9 cu.ft., occupied per pound of ammonia, will be 9.682, and the compressor will deliver

$$435 \div 9.682 = 44.9$$

a loss of

$$48.33 - 44.9 = 3.43 \textit{ lb.}$$

and, figuring 0.4 lb. per ton, 8.8 tons.

By properly insulating the suction pipe and regulating the flow of ammonia to the compressor much of this loss would have been avoided. The operating engineer was perfectly willing to be shown and at once gave his men the correct instructions. There are many such cases and the sooner the engineer learns the use of the thermometer the better it will be for both owners and manufacturers.

In a case of the other extreme there were two compressors, each manipulated in such a manner that a great amount of liquid was allowed to enter the cylinders. The compressors were frosted all over and the discharge pipe was barely hand warm. The worst of it, however, was the fact that this liquid was taken direct from the ammonia liquid receiver in the engine room, forming, one might say, a short-circuit, and interfering very seriously with obtaining results in the cellars and the beer cooling on account of a rising back pressure up to about 45 lb., even when the machines were running full speed.

To ascertain the loss of capacity by using the discharge temperature, assume a condenser pressure of 185 lb.; the discharge temperature of the gas taken from test records is about 240 deg. F. for 15 lb. back pressure, but was lowered to 100 deg. by the injection ammonia, which was lost to the refrigerating outfit.

Taking the compressors referred to above, having a capacity of about 40 lb. of ammonia per minute under 15 lb. back pressure (corresponding to 82 per cent. efficiency), the loss would be 2800 B.t.u. per minute. If the latent heat is 500 B.t.u., the loss would be 5.6 lb. Assuming 0.4 lb. per minute, the loss becomes 14 tons. While the latter case is exceptional, similar ones have been found in vertical as well as horizontal machines.

An operating engineer is not necessarily incompetent because he does not use thermometers, but he would be more competent if he did, as they teach him the relations existing between volumes and temperatures; and when he once

*Abstract of paper read by E. N. Friedmann at the St. Louis meeting of the American Society of Refrigerating Engineers.

accustoms himself to using this method, he likes it, and in many cases he can run the machines slower.

Generally speaking, more mistakes are made in allowing too much liquid to enter the compressor than the opposite, and as it is important to give the engineer some guide to prevent this, the following table has been compiled for his instruction:

Gage Pressure	Boiling Point, Deg.	Temperature at Which Suction Gas Shall Enter Compressor, Deg.
12.25	— 5	+ 3
15.67	0	+ 7
19.46	+ 5	+11
23.64	10	+16
28.24	15	+20
33.25	20	+25
38.73	25	+28
44.72	30	+33

The engineers of the manufacturers have been of great assistance to operating engineers, who seldom have access to the data of the manufacturer. It is to be hoped that some tables with easily understood data will be put within reach of the operating man, as they will make him more valuable to his employer and help the manufacturer as well, as in many instances the expense and time for tests may be saved.

Steel versus Iron Pipe in Refrigerating Work*

So called steel pipe is made from a purer iron than wrought-iron pipe, and, from an engineering standpoint, is more desirable as the material is more uniform, easier to weld and the finished product smoother, with no blisters. Wrought-iron pipe is not regular in quality or material and the method of manufacture makes it difficult to detect its defects when it has once been made into pipe.

Wrought-iron skelp and pipe-steel skelp, on an average, have the following physical properties:

	Pipe Steel	Wrought Iron Pulled Longitudinally
Tensile strength, lb. per sq.in.	58,000	46,000
Elastic limit, lb. per sq.in.	34,000	28,000
Elongation, per cent. in 8 in.	22	12
Reduction in area, per cent	55	25

Wrought iron will vary from 4 to 16 per cent. in elongation while steel is expected to range between 19 and 25 per cent. Pulled transversely, puddled iron seldom gives 35,000 lb. per square inch tensile strength, and the elongation and the reduction in areas are proportionately low and variable.

Most refrigerating engineers handle pipe from 2 in. in diameter down, made by the butt-weld and lap-weld process; 1¼-in. pipe and under is butt-welded unless redrawn.

*Abstract from paper read by P. DeC. Ball at the St. Louis meeting of the American Society of Refrigerating Engineers.

As showing the average of bursting tests on steel and wrought-iron pipe 1¼ and 2 in. in diameter, the accompanying table is supplied by F. N. Speller, of the Engineers Society of Western Pennsylvania.

It is common experience that both steel and wrought-iron pipe can be readily and perfectly threaded if the cutters have the proper rake. Dies for threading wrought-iron pipe require only about 12 deg., while steel pipe should have about 18 deg. rake, and about 6 per cent. more power is required to thread steel pipe.

For ice-making and refrigerating tanks, where the pipe is constantly submerged in brine, there is no pitting or corrosion, but in submerged condensers heavy pitting in spots is observed.

It is the writer's personal experience that submerged iron or steel pipe has never corroded sufficiently in an ice or brine tank to cause trouble, and he has taken out both iron and steel coils after 15 years' service and used them in making new coils. Of course, this does not apply where the pipe is exposed for several months in the year to oxidization by salt, air and moisture.

No instance is known to the author wherein steel pipe is not as good, or even better, than wrought-iron pipe; 30 per cent. of genuine wrought-iron pipe has been found defective and never more than 7 per cent. of steel pipe, the average being less than 2 per cent. at 500 lb. under air test and occurring where the mill was too economical and cut the pipe too near the tong end.

When iron pipe is bad, it is very bad, probably caused by the large variation in the quality of the material as steel scrap of various composition is used as well as badly distributed slag.

Galvanizing steel pipe, with its uniform quality of material, absence of slag and of laminations, is ideal for condensers; galvanizing iron pipe is a source of trouble as the pipe is pickled or cleaned by hot sulphuric acid, which eats off the mill scale and slag, sometimes into the interior of the pipe. Furthermore, it stands the air under the water test, is made up into condenser stands, erected and put into operation. The ammonia decomposes the spelter with which the pipe was galvanized, and then the leaks and the engineer's troubles begin at the same time.

From 33 years of personal observation, constructing, erecting and operating ice-making and refrigerating machines, absorption and compression types, and using iron pipe for the first 14 years, and iron and steel pipe for the next 19 years, the author is convinced that local conditions only govern the corrosion of pipe and that chemically and mechanically mild-steel pipe meets the requirements of the refrigerating engineer in all respects.

AVERAGE OF BURSTING TESTS ON STEEL AND WROUGHT-IRON PIPE

Sizes, Inches	Kind of Pipe	Length, Feet	Number of Samples Tested	Average Weight per Foot, Pounds	Average Thickness, Inches	Average Bursting Pressure, Pounds per Square Inch	Average Maximum Stress per Square Inch on Wall of Pipe, Pounds (Barlow Formula)
1¼	Standard butt-weld steel	18.0	10	2.26	0.139	5,808	34,600
1¼	Standard butt-weld wrought iron	18.5	10	2.21	0.147	4,891	29,800
1¼	Standard butt-weld wrought iron	17.5	10	2.21	0.136	5,283	30,900
1¼	Standard redrawn butt-weld steel	15.0	14	2.21	0.136	7,400	44,800
1¼	Extra strong butt-weld steel	20.0	11	2.86	0.181	10,640	54,000
1¼	Extra strong butt-weld wrought iron	20.0	10	2.95	0.188	5,895	26,700
2	Standard lap-weld steel.	20.0	10	3.67	0.155	6,645	51,000
2	Standard lap-weld wrought iron	20.0	10	3.65	0.152	3,213	(Purchased 25,100 as lap weld but looks like "butt weld")
2	Standard butt-weld steel	19.0	11	3.53	0.153	4,951	43,400
2	Standard butt-weld wrought iron	17.5	10	3.70	0.156	3,687	28,600
2	Tubing (4 lb.) lap-weld steel	21.5	10	4.26	0.178	7,361	47,800
2	Extra strong lap-weld steel	18.5	10	5.01	0.218	7,909	43,300
2	Extra strong lap-weld wrought iron	20.0	10	4.79	0.206	6,349	36,500
2	Extra strong butt-weld steel	20.75	10	5.06	0.220	7,661	41,700
2	Extra strong butt-weld steel	20.5	10	4.91	0.213	8,238	45,900

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Contents

PAGE

New Generating Station, Portland, Ore. 942
Massachusetts License Law Revised 946
Notes on Grouting Bedplates..... 947
Tom Hunter, Hoisting Engineer.... 948
Efficiency of Reciprocating Engines 950
An Analysis of Some Recent Gas Engine Failures 954
The Bogert Auxiliary Heater..... 956
Gas Power in a Manufacturing Establishment 957
The Nonprecipitation of Calcium Chloride from Brine by Ammonia 958
Operating Ammonia Compressor by Aid of Thermometers..... 959
Steel versus Iron Pipe in Refrigerating Work 960
Editorials 961-962
Practical Letters:
Example of Poor Designing.. Plugged Boiler Head .... Oil Grooves....How He Got a Raise ....Noisy Valve Gear Tappets ....Excellent Steam Charts.... Centrifugal Pump Repair .... Homemade Water Heater .... Size of Tank Required.....965-967
Discussion Letters:
Potblyn, Pump Doctor....Sand for Hot Boxes....Air Compressor Running Under....Burning Fuel Oil .... Graft .... Effective Pressure of a Screw.... A Twenty Four Hour Log....Trouble with Leaking Tubes.....968-971

POWER

Pipe Flange Bolting

In considering the question of flanges for pipe and fittings more often the whole attention is given to these parts themselves and none at all, or very little at the most, to the bolting. For this reason, perhaps, the average pipefitter or steam-plant operator does not fully realize the importance the proper bolting together of flanges has in putting up a pipe line properly.

In the first place, wherever possible, through bolts should be used, and if the design of any particular fitting or some existing condition does not permit of this, then it will very often pay to so change the design or condition that this rule can be carried out. The man in the drawing room who designs the necessary special fittings and lays out the work is usually responsible for the tap and stud bolt as it is so easy to stick one in here and there rather than to make some slight change in the design. A short time spent in the mill under the direction of a good master mechanic will, however, soon relieve him of this tendency and he will see for himself the wisdom of using through bolts in all cases.

The bolts connecting pipe flanges are subjected to three distinct loads: that due to the torsional stress because of the friction between the threads of the bolts and the nut; the tension due to screwing up, and the straining action due to the pressure in the pipe line. The total stress or load on the bolt is, therefore, so far as all practical purposes are concerned, the sum of these three.

The greatest stress is that caused by the screwing up of the nut, and calculations regarding it are of little or no value as the stress is entirely dependent upon the judgment of the mechanic doing the work. A number of tests have been made on bolts of various sizes and with different-length wrenches, but the results have not been uniform. It has been learned, however, that the load varies about as the diameter, for the mechanic will usually graduate the pull on his wrench proportionally with the size of the bolt. It was learned also that the results were more uniform and the loads a trifle higher when using faced nuts and co-relating surfaces.

In addition to this tensile stress there is also considerable torsion taking place at the same time, and these two stresses combined have often been so great as to result in a twisted-off or broken bolt. Often, no doubt, the combined force expended in tightening a nut exceeds the elastic limit of the bolt and will cause a slight fracture, so that when the pressure is turned on the pipe the bolt breaks.

Since the judgment—and sometimes the strength—of the mechanic is the only governing factor for these two stresses, there is room for a little standardization with the view to limiting the length of wrenches to be used on different bolts. The use of a piece of gas pipe, so often slipped over the wrench in order to get a greater leverage, might also be eliminated.

The third stress—that due to the pressure in the pipe—is hardly ever great enough to cause any trouble. Furthermore, it is automatically regulated, as it were, for the total load due to the internal pressure varies with the diameter of the pipe and, consequently, decreases as the size and the number of bolts corresponding to the smaller sizes of pipe decrease.

License Graft in New York

It is a funny thing about New York engineers that for several years they should have been nursing a rising indignation, not because they were called upon to pay graft when they went after licenses, but because the "price of licenses" had been raised from twenty dollars, as it was in the good old times when POWER exposed the practice with the aid of Mr. Van Stcenburg in 1898, to fifty or more.

For several years following the reorganization of the department, consequent upon our exposé, it appeared to be con-

ducted upon an honest basis. Of late years, however, it has been common report that graft was again being demanded and in larger amounts than formerly. It has been impossible to find anybody, however, who would give definite information upon the subject without putting such restrictions upon the use of it that it could not be submitted to the attention of the authorities nor used as the basis of an exposure.

Recently, William H. Black applied for a license and was not able to pass the examination. He was not satisfied that the examination had been on the square, and took steps to trap the inspectors.

Obtaining money from the Society for the Prevention of Crime, the numbers of the bills having been noted, he returned for a second examination. This money was handed to a subordinate, who, according to reports, said: "I don't want it for myself; I have to get it for the men higher up."

The "men higher up" were apparently satisfied, for Black was reëxamined and received his license.

The Society for the Prevention of Crime and Commissioner Waldo, of the police department, set the trap into which the inspectors fell. The result was that one branch of the police department raided another. When the examining inspectors were arraigned and searched at the detective bureau, several of the bills which had been given to Black were found on one of the inspectors.

The men involved were suspended, and Commissioner Waldo began an investigation which led him to conclude that the boiler-inspection department was so pregnated with graft that nothing less than a complete cleaning up of the department would remedy matters. Consequently, Lieut. Breen, sixteen patrolmen and four clerks were ousted and transferred to various stations through the city. A new boiler squad has been organized under the command of Capt. James H. Gillen.

It is reported that Police Commissioner Waldo will advocate the removal of the department which has to do with the licensing of engineers and the inspection of boilers from the police department, and place it in the fire department.

A much better arrangement would be to allow the licenses to be issued by the commissioner of licenses on the recommendation of a board composed of appointees from the National Association of Stationary Engineers, the International Union of Steam Engineers and a lay member, as proposed in connection with the revision of the city charter.

The possibility of the perversion of their opportunities to such base uses is the best argument which the opponents of license laws for engineers have to offer, and if the alleged facts and conditions are established we sincerely hope that the grafters will receive retribution commensurate with the immense sum in which they will in that case have mulcted the engineers of New York City and the disrepute which they will have cast upon governmental supervision of steam plants and engineers.

Back Pressure Valves

The back-pressure valve is a simple piece of apparatus which enters into the installation of nearly every power plant and which should have attained a high degree of perfection if time and experience are to be considered worth anything. As a fact, however, there appears to be room for improvement and adaptation to the more precise service frequently required of it.

A back-pressure valve is intended to maintain a constant back pressure on the exhaust-steam system of a plant regardless of the volume of steam which may pass through it. If exhaust steam is used for heating or drying purposes, there will be a great variation in the volume of steam used at different times and the excess steam furnished by the engine must pass to the atmosphere through the valve. It is quite evident that if five pounds pressure is all that is necessary for the heating or other processes for which exhaust steam is used, there is a loss of power when the pressure rises above five.

The back pressure is a very potent factor in determining the efficiency of an engine and the loss occasioned by increasing it unnecessarily will in most cases amount to a sum entirely incommensurate with the price of the back-pressure valve. If this impairment of the efficiency came when the exhaust steam was being used it would be immaterial, but it is occasioned by the effort of surplus steam to escape to the atmosphere, when increased efficiency on the part of the engine would have its full effect.

With some of the simpler forms of valves in the sizes and proportions in which they are usually installed, the pressure, when it is necessary to discharge all of the steam to the atmosphere, will sometimes rise to nearly twice that at which the disk begins to lift, with the result that added work is placed upon the engine with an absolute loss. It is frequently necessary to use a valve of two or more times the area of the pipe in order that the total lift shall be small and that the effective pressure remain constant or nearly so.

With modern systems of heating and drying, it is possible to secure results at one and two pounds pressure that were impossible before with five pounds, and it becomes even more necessary to operate within narrow limits if the best results are to be obtained. The combination of a perfectly balanced valve which has no tendency to open at any pressure and a damper regulator having a large diaphragm sensitive to within one-quarter of a pound has insured close working and a constant pressure in the practice of one of our correspondents. This combination is more expensive than any self-contained back-pressure valve, but the price is wholly unimportant when one considers its earning capacity.

In those systems where there is a very great variation in the volume of steam used for industrial purposes the combination before referred to, together with a similar combination for admitting live steam to the system, can be made to work within one-half of a pound, so that the pressure on the low-pressure system will be constant whether five per cent. only of the steam is being used or all of the exhaust, together with a very considerable amount of live steam. It is a valuable combination in those cases where heating is done at practically atmospheric pressure.

It is possible that some of the manufacturers of back-pressure valves may find it profitable to make available a self-contained valve operating upon some such principle, or at least which will maintain a constant pressure in the exhaust-steam system under a widely varying rate of discharge.

Did you notice that in the big Delray boiler test the highest capacity, 214.8 per cent. of the normal, was reached when the furnace was making 16.5 per cent. of CO_2?

Weir's Rotary Air Pump

Several designs of rotary air pumps suitable for use in conjunction with condensers and adapted to be driven by a high-speed electric motor or steam turbine have, according to *The Mechanical Engineer*, recently been patented by William Weir, of G. & J. Weir, Limited, Cathcart, Glasgow. Fig. 1 is a plan view of a rotary displacement pump of the gear-wheel type adapted for use as an air pump with the top plate and suction connection removed, and Fig. 2 a sectional elevation on the line *Z* — *Z*. A sectional elevation of a pump similar to that shown in Figs. 1 and 2, but adapted for use as a dry-air pump, is shown in Fig. 3, and Fig. 4 is a plan view of a combined wet- and dry-pump set.

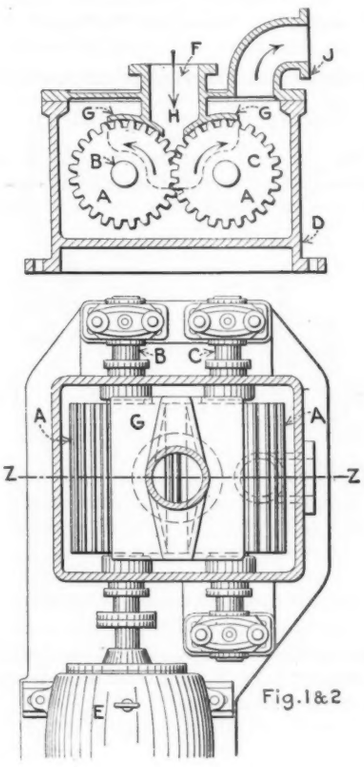


Fig.1&2

Referring first to Figs. 1 and 2, the pump comprises two toothed-gear wheels *A* meshing with one another and mounted on parallel shafts *B C* in a closed casing *D*. The ends of the shafts pass out of the casing through stuffing boxes, the shaft *B* being supported at one end by a bearing, the other end thereof being coupled to a motor *E* for driving the pump. The shaft *C* is supported in bearings at each end. The suction chamber *F*, at the top of the pump, is provided with a flange for connecting to the condenser, and with a yoke piece *G* fitting circumferentially on the gear wheels *A* and extending from a point slightly below the meshing point of the wheel teeth approximately over one-quarter of the circumference of the wheels, and also extending radially over the ends of the wheels as shown. An opening *H* is formed in this yoke above the meshing point of the wheels and serves as a suction inlet. The discharge chamber of the pump is constituted by the casing *D*, a pipe connection *J* being provided for the outlet of the air. This connection is so arranged at the top of the casing that the entire casing can be filled with water, which thereby acts as a seal for the suction chamber *F* and stuffing boxes, thus preventing any leakage of air. The direction of rotation of the gear wheels *A* is such that they sweep out the air from the suction chamber *F* through the opening *H* and carry it past the yoke *G* and discharge it into the sealing water in the casing, whence it escapes through the discharge pipe *J*.

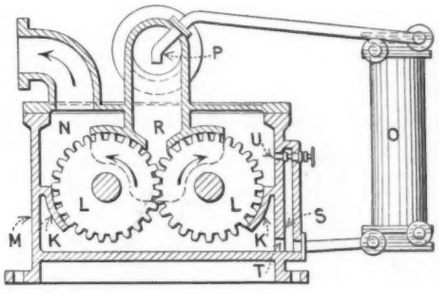


Fig.3

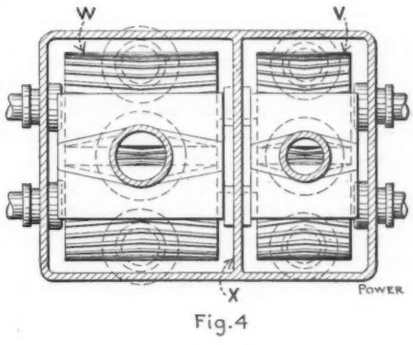


Fig.4

In Fig. 3 is shown a pump similar to that in Figs. 1 and 2, but particularly adapted for use with a condenser as a dry-air pump. In this construction two additional longitudinal shrouds *K* are arranged around the circumference of the gear wheels *L*, so that the space at the bottom of the casing *M* is isolated from the discharge chamber *N* at the top of the casing. The sealing water of the pump is thus compressed in the bottom of the casing, and as its temperature rises in course of working, it may be advantageously passed through a cooler *O* and returned through a jet *P* into the suction chamber *R*. An adjustable bypass may also be fitted as shown, enabling a certain proportion of the water to return to the discharge side of the pump without passing through the cooler *O*. This bypass consists of a chamber *S* formed on the outside of the casing *M* and communicating therewith through the bottom opening *T* and the top opening *U*, this latter opening being regulated by a screw-down valve as shown. A dry-air pump of this kind may advantageously be combined with a wet pump, which may be a centrifugal pump mounted upon the same shaft and adapted to withdraw the water of condensation from the condenser; or alternatively as shown in Fig. 4, instead of the centrifugal pump a second pump *V* of the gear-wheel type may be contained within the casing of the dry pump *W* and mounted upon the same shafts, but separated therefrom by a partition *X*. The dry pump if necessary may be at a lower temperature than the wet pump.

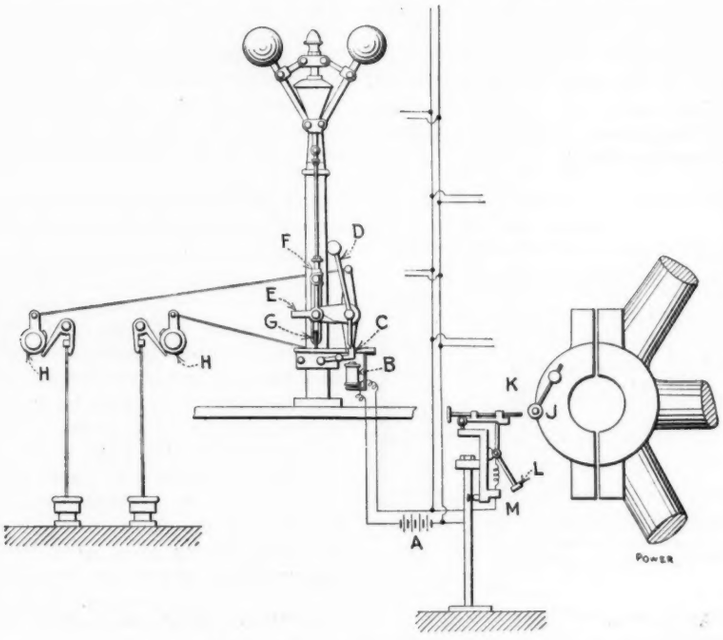
It is usual to inject a certain amount of cold water into the suction pipes and chambers of dry-air pumps to condense the vapor and to absorb the heat of compression. In dry-air pumps of this type such injection water may be dispensed with, as the water admitted into the suction chamber as leakage serves the same purpose; thus it is unnecessary for the suction yoke to fit very closely over the gear wheels, as this water leakage is an advantage. Further, in cases in which a certain amount of liquid is also passing through the pump, the gear wheels are formed with teeth of a helical or double helical shape (see Fig. 4) to allow the liquid entrained between the teeth to escape longitudinally. The suction may be increased by means of a steam jet which may be of the Parsons augmenter type, such steam being condensed by a jet of water supplied by water circulating through the pump and a suitable cooler.

In the pumps described for each revolution of the wheels the displacement or suction will approximately be the circumference of one wheel multiplied by the depth of the tooth, less the amount of leakage at the circumference and ends of the suction yoke, and such leakage for any given difference of pressure will be a constant, and accordingly represent a very low percentage of leakage when the wheels are running at high speeds. Further, any portion of the gear wheels may be guarded by cover plates to minimize the surface friction of the wheel teeth, which rotate rapidly in the case. It is also evident that the pumps may be utilized for withdrawing the entire product from a surface condenser, comprising the condensed water, air and vapor, and the use of the pump is not necessarily restricted to the pumping of the air and aqueous vapor alone. In such cases the sealing water will be the discharged condensed water, and the capacity of the pump will accordingly be governed by the temperature of such water.

Rockwells Automatic Engine Stop and Speed Limit

A new automatic engine stop and speed limit, illustrated herewith, has recently been patented by H. R. Rockwell, 209 Spring street, Alton, Ill. It is composed of a governor which is fitted with a rocker arm, weight and detachable lever.

In the drawing is shown a flywheel in which is inserted a split stud fitted with a spring having a weight attached to the outer end. At a convenient point a switch is placed on which is fitted an adjusting screw which is used to regulate the speed limit of the engine. There are also arranged a pawl, switch blade, etc.



ENGINE STOP AND SPEED LIMIT

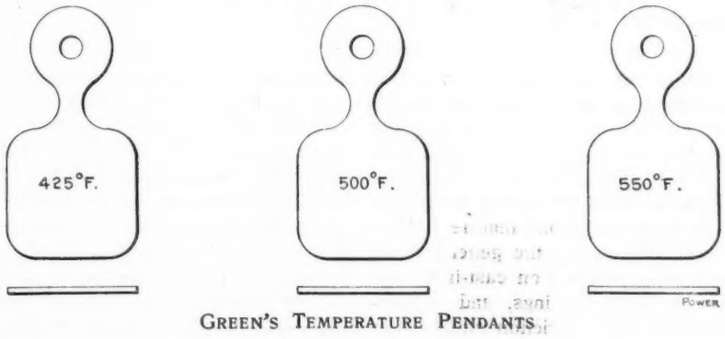
The operation of the appliance is as follows: If the electric circuit is closed by any means through the battery *A*, it will energize the magnet *B*. This will attract the armature *C* and release the weight *D* which will fall on latch hook *E* and detach it from slotted link *F*. The rocker arm will then descend to the stop *G*, which will bring the safety cams *H H* into a position to prevent the steam hooks from engaging with the catch blocks on the steam-valve stem. The engine may also be stopped by closing any of the switches in the line, or by the speed-limit appliance.

When the speed limit operates the weight *J* is thrown out by centrifugal force, in proportion to the rotative speed of the flywheel, but the adjusting screw on the limit switch is so set as to allow the weight to just miss the screw *K* when the engine is running at normal speed. Should the speed accelerate from any cause the weight will fly out further and striking the adjusting screw will trip the pawl *D*, close the circuit through *L* and *M* and stop the engine.

This appliance simply disconnects the governor from the rocker arm, thereby relieving the governor of all shock and jar. It requires no alteration of the governor except substituting the lower rod connection for the slotted link and extending the pin to carry the latch hook. This stop is very simple and can be applied to any Corliss or other engine having a liberating valve gear.

Green's Temperature Pendants

The Green Fuel Economizer Company, Matteawan, N. Y., has perfected a system of determining the temperature of the gases by using the tensile strength of metal pendants instead of the melting point as the true indication of temperature. The pendants are made with a large body, having a certain definite weight, suspended from a narrow neck, as shown in the accompanying illustration. The composition of the metal may be varied and the cross-section of this neck is adjusted until the body of the pendant will pull the neck in two and fall at some desired temperature.



GREEN'S TEMPERATURE PENDANTS

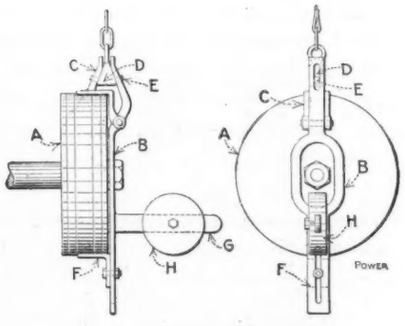
In actual use, the pendants are hung upon a wire hook, which is introduced into the flue with the pendant at the desired point, beginning with the lowest temperature pendant, and proceeding until the one is found which will not fall off after five or ten minutes' exposure. The flue-gas temperature will then be somewhere between the temperature marked on the last pendant and the next to the last pendant used.

Pendants for three temperatures have been perfected, namely, 425, 500 and 550 degrees Fahrenheit, representing respectively the temperature at which the use of the economizer is justified with coal at commercial prices, the temperature at which an economizer is a good investment in all cases, and the temperature at which neglect to install an economizer becomes waste.

Three tables have been calculated for use in connection with these pendants.

Piston Handling Clamp

The accompanying drawing shows an engine piston-handling device so designed that the piston will hang vertically when removed from the cylinder. It is the invention of J. G. Koppel, 192 West David street, Montreal, Can.



CLAMP FOR HANDLING PISTONS

Referring to the illustration, *A* is an engine piston; *B* is the main lever of the piston clamp; *C* is a top lever and *D* is a triangular block. The balancing pins are shown at *E* and the adjustable bottom clamp at *F*. The bottom counterweight rod *G* supports the counterweight *H*. The device is used as shown.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Example of Poor Designing

The station here described was built to supply light to a town of about 6000 people and to furnish power for a street-railway line. The load was not expected to run over 400 horsepower for the first few years, with variations running much below that figure a large part of the time.

Fig. 1 shows the general arrangement of the driving and generating machinery; there being water available for certain periods, the plant had both steam and water power.

As may be seen, the two waterwheels are belted to the jack shaft and connected by friction clutches so that either one or both may be run as desired. The shaft is 70 feet long and solid throughout so far as cutting it into parts while in motion is concerned, and there is no space left between the quill bearings for the pulleys driven by the waterwheels to put in a clutch by way of improvement. In consequence of this arrangement, continuous service depended upon there being no breakdowns of the shaft or hot bearings.

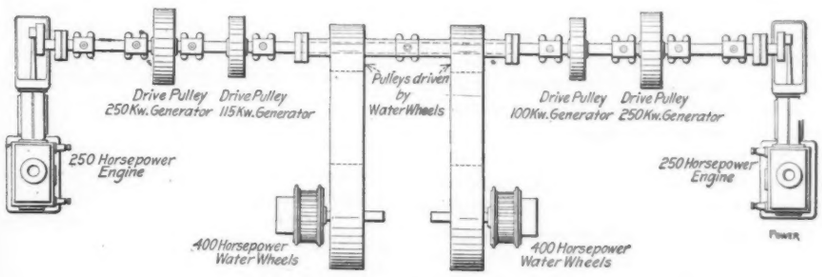

Drive Pulley 250 Kw. Generator
Drive Pulley 115 Kw. Generator
Pulleys driven by Water Wheels
Drive Pulley 100 Kw. Generator
Drive Pulley 250 Kw. Generator
250 Horsepower Engine
250 Horsepower Engine
400 Horsepower Water Wheels
400 Horsepower Water Wheels
POWER

FIG. 1. LAYOUT OF APPARATUS

This arrangement entailed a waste of power also, for during the day one of the 250-kilowatt generators was run for the railway load and one of the smaller machines for the day lighting load, and there was hardly ever any need of running the whole line during periods of light load. Another bad feature was that the drive pulleys for the generators did not run on quills but on cast-iron bushings with babbitt linings, and as these were connected by friction clutches, the side pull of the clutch soon wore the bushing so that the pulley ran out of line. On an 84-inch pulley with a 24-inch face the effect of this action can be imagined. Also, in order to repair the bushings in these pulleys, it was necessary to shut the shaft down, which could only be done between the hours of 12 midnight and 6 a.m.; had it been possible to run half of the shaft at a time, this work could have been done during the day.

It will be seen that an engine was provided at each end of the shaft, also connected by a friction clutch. The bad feature about this arrangement was that the engines were too far removed from each other and were about 8 feet below the generator floor. This kept the man who was operating the station on the jump most of the time, a fact detrimental to good service.

In Fig. 2 is shown the manner in which the water flowed to the wheels. The location of the head gates caused all the water supplying the wheels, and also the surplus flowing over the spillway, to pass through a comparatively small opening. As a consequence, in times of high water, when the river was full of all kinds of débris, it was a common occurrence for these gates to become so plugged up that barely enough water would pass through for the operation of the plant and in case it was necessary to do any repairing inside the wheel cases it was impossible to shut the head gates on account of the matter caught under them.

A further drawback was that there were no shut-off gates placed just in front of each wheel so that one could not be examined without stopping the other. It will be apparent that had the head gates been placed inside the spillway so that only the water required for power would pass through them, the danger of refuse collecting would be much reduced.

The different floors and the hight of the generator floor above the wheel pit are shown in Fig. 3. In the first plan the governor for the waterwheels was placed on the gallery 30 feet below the upper floor; this was later moved to the main floor so as to control the wheels without losing sight of the switchboard.

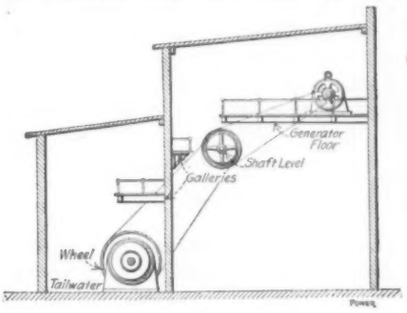


FIG. 3. CROSS-SECTION OF PLANT

It was necessary to make the engine and generator room of this station very large on account of the space required for the belt drives; also, one of the engines had to be a long distance from the boilers. If vertical wheels direct-connected to generators, with the generators placed on the level of the main floor, had been installed, one driving a direct-current machine and the other an alternator, and had the engines been put next to the boiler-room wall and connected to two machines on the same shaft so that one engine could furnish power

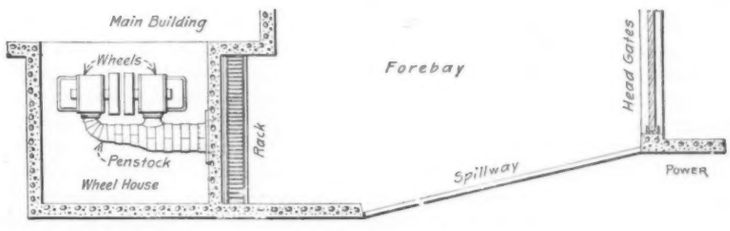


FIG. 2. PLAN OF FOREBAY AND WHEEL HOUSE

for both the lights and the railway, all the belting, pulleys and shaft would have been unnecessary. Furthermore, the plant could have been made much more compact and easier to operate, and the first cost would have been less.

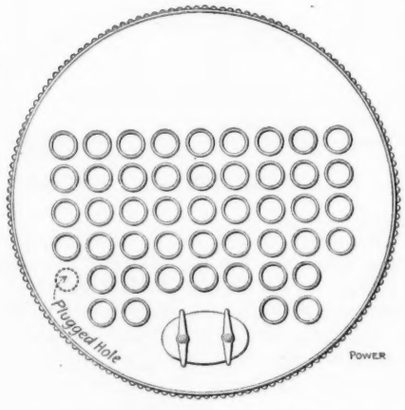
This station was built in 1903 and while a large amount of money was spent on the original installation, it was probably one of the most difficult plants of its size to operate successfully in the country, because of the lack of common sense exercised in its design.

G. H. KIMBALL.

East Dedham, Mass.

Plugged Boiler Head

Some time ago a firm of manufacturers placed an order for a horizontal return-tubular boiler with a firm of boilermakers who had a reputation of turning out a first-class boiler. About nine months after the boiler had been installed, the engineer noticed a leak in the head that had the appearance of a crack. He promptly notified the inspector of the insurance company who was carrying



WHERE TUBE SHEET WAS PLUGGED

the risk, and he found that the supposed crack was a plugged tube hole, located at the point indicated by the dotted circle in the accompanying illustration.

A mistake had been made by the boilermaker who had cut out the tube holes, and afterward the hole had been tapped, threaded and countersunk. A plug had been screwed in, cut off and afterward riveted. This had been carefully filed and the file marks removed by scraping. The whole was then painted, making detection almost impossible until the leak showed it up.

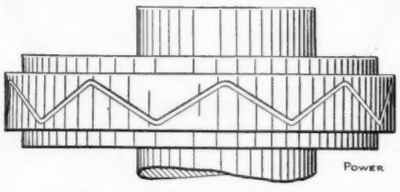
In following up the case, to see who was responsible for this job, it was found that the firm who built the boiler knew nothing at all about it. The shop foreman denied having ordered it done, and the shop inspector had passed the boiler without knowing anything about it. Finally the man who had laid out the head acknowledged that he had made the mistake and had taken this way of covering it up, believing that it would never be detected.

W. G. WALTERS.

Stratford, Can.

Oil Grooves

A power plant which had been running for some time had four engines fitted with bronze crank brasses. All of the crank bearings were running hot. In a few days after one set of crank brasses had been removed and oil grooves were cut in



OIL GROOVE IN ECCENTRIC

them, this bearing was running as cool as any. Oil grooves were then cut in the brasses of all of the engines and they are now running properly. The oil grooves remedied the trouble as they placed more surface of the journal in contact with the lubricant.

An eccentric having a diameter of 24 inches was running at high speed and pulling a heavy valve. It gave trouble continually by working loose on the shaft, even though clamped with two setscrews. Oil grooves were cut as shown in the illustration. The strap was lined with babbitt and upon starting up no further trouble was encountered. Unless the liners between the two sections of the strap are properly placed the strap may spring and stick. The liners should cover the entire surface of the lug. Hot eccentric straps are caused as often by this defect as by poor lubrication.

C. R. MCGAHEY.

Baltimore, Md.

How He Got a Raise

I am employed by a firm which has plenty of money but looks upon the engineer as a necessary evil and has never thought of giving him a raise. I had asked the manager twice for more pay and got no satisfaction and I gave him to understand that I was dissatisfied.

I kept on the lookout for another job. A week later an article came out in POWER, on the first page, called "Hope." I read it and decided to frame it and hang it so that when the manager got rubbering around, it would either be a case of getting fired or getting a raise.

That evening I clipped the article and had it framed and the next morning hung it up in the engine room.

About two hours later the manager made his daily round and spied "Hope" hanging on the wall.

He read it and walked out without saying a word.

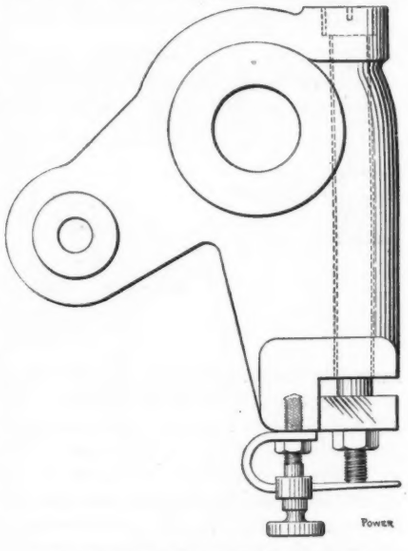
Saturday, which was also pay day, came and to my delight the article "Hope" with a 35-cent frame brought me a $3 a week raise.

EDGAR G. SCHINDLER.

Roxbury, Mass.

Noisy Valve Gear Tappets

About a year and a half ago I took charge of a large, new mill steam plant, one of its engines being a 2200-horsepower, cross-compound Corliss engine, equipped with the Brown valve gear. For over a year the valve gear ran very quietly, but during the last few months the tappets have made considerable noise as they fell into place. The noise was more pronounced on the low-pressure side, where the parts are large and heavy. To stop the noise, I first tried a leather washer under the tappet bolt-head with



SPRING ON VALVE-GEAR TAPPET

poor results, as the leather soon wore out and the tappet block dropped too low. Rawhide was not much better. Frequent applications of cylinder-oil would stop the noise as long as the oil lasted, but this method was inconvenient, and made a mess of the valve gear.

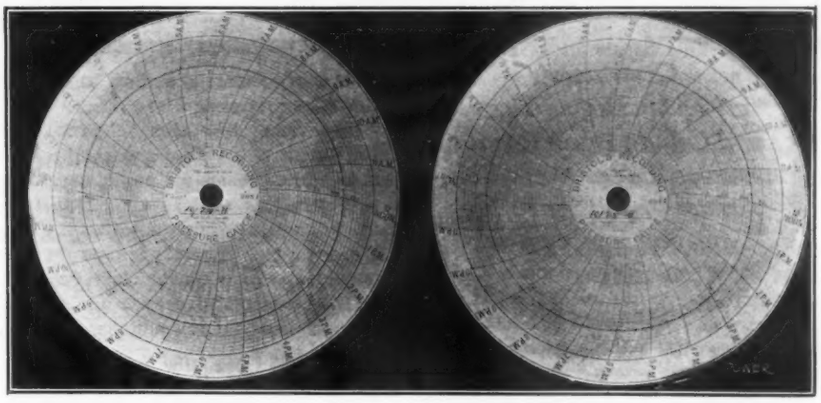
I effectually stopped the noise by using a flat spring, as shown in the sketch. The spring is of steel, and is very simple to make and attach. I put two on during one noontime shutdown. The thumbscrew permits a close adjustment, and if the tension is right, the tappet will drop quietly into place. Too much tension will prevent the tappet from dropping low enough to permit the latch to hook on. I have used the springs for some time and they work to perfection. The length of the spring depends on the size of the bell crank.

J. JOHNSON.

Fall River, Mass.

Excellent Steam Charts

The accompanying illustrations are reproductions of photographs of two steam-chart records taken in my power plant on October 24 and 25. Can anyone beat



CAN YOU BEAT THESE STEAM-PRESSURE RECORDS?

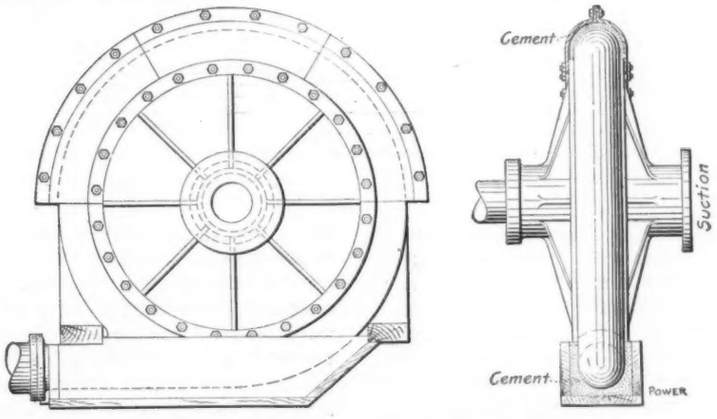
them? Steam was generated in four water-tube boilers.

E. STANLEY THOMAS.

Fremont, O.

Centrifugal Pump Repair

The casing on the centrifugal pump of a suction dredge gave out. The pump had a 22-inch discharge and the material that passed through it varied from clay silt to coarse gravel and occasional boulders. One of the latter had been taken in and slammed a 7x12-inch irregular piece out of the rim.



METHOD OF REPAIRING THE PUMP CASING

An examination showed that the casing had worn from a thickness of about 2 inches to a thin shell; in some places it was almost through. A new pump was not at hand and time was precious. Therefore three cast-iron segments, in two parts each, were made with a radius of about 4 inches greater than the upper pump casing. Holes were drilled to suit the studs on the side flanges and longer studs were substituted for the regular ones. The joint where the two parts of each segment came together was flanged and drilled for bolts. These patches were bolted on and a cement grout was poured between the two castings.

On the underside of the pump, between the supporting lugs and around the outlet, a wooden trough or box was built to leave a clearance of about 6 inches between the sides and bottom and the pump. This was filled with cement.

After being patched in this manner the pump was run for some months before being replaced by a new one.

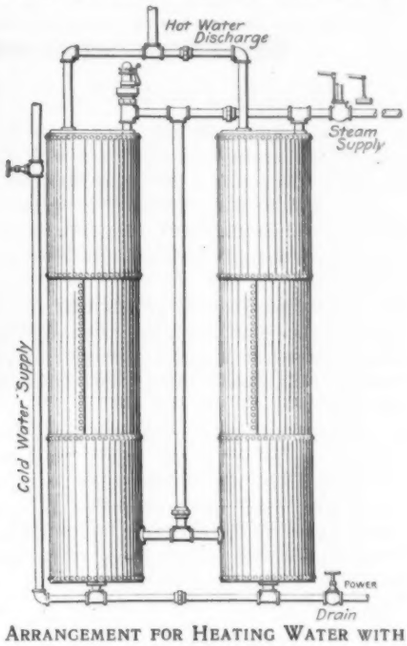
THOMAS H. HEATH.

Seattle, Wash.

Homemade Water Heater

I am engineer for an Indian school which has a capacity of about 200 persons, including the Indian children and the instructors. Formerly the hot water for bathing and domestic purposes was furnished to each building by a small heater and tank. This arrangement was not very satisfactory, as it required from four to five hours to heat the water and continuous attention, the heaters being small and not of the coal-magazine type.

I removed two of the tanks to the power house, connected the cold-water inlet at the bottom, and the hot-water outlet at the top of the tank, as shown in the accompanying figure. I then connected the live-steam main into the top of the tanks, running the pipes nearly to the bottom and I also connected the steam main into the sides of the tanks to help the circulation. As the water supply is under a constant pressure of



ARRANGEMENT FOR HEATING WATER WITH LIVE STEAM

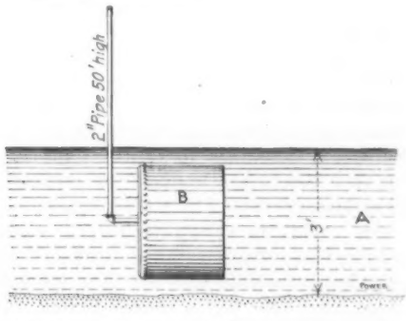
40 pounds per square inch, I placed a reducing valve on the steam main, allowing only 45 pounds of steam on the tanks. A safety valve is also provided to relieve the tanks of overpressure at any time. Although the water is carried over 300 feet before it is used, the scheme works very satisfactorily at all times.

HUGH L. RUSSELL.

Keams Canyon, Ariz.

Size of Tank Required

A stream of water *A* runs 6 miles per hour. A tank *B* is immersed in the river and a 2-inch pipe 50 feet high is connected to the tank.



HOW HIGH WILL THE WATER RISE IN THE 2-IN. PIPE?

What size of tank will be required to force the water out at the top of the 50-foot pipe? Will a check valve be necessary in the 2-inch pipe?

H. S. FITZGERRELL.

Los Angeles, Cal.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Potblyn, Pump Doctor

An article published some time ago under the above title concludes with the query: "Why will an air pump work with a vacuum in the suction pipe while a boiler-feed pump will not take water from a heater in which there is a vacuum?"

Briefly, the reply would be that an air pump has less clearance than a feed pump and has to deal with water at a lower temperature than that delivered from a heater.

Perhaps the commonest and most efficient type of air pump (apart from the Edwards) is the single-acting vertical type with head and foot valves as well as a valve in the bucket. Fig. 1 shows diagrammatically such a pump. The foot valve is closed because the pressure in the condenser is less than that in the clearance space between the foot valve and the bucket; the bucket valve is also closed because there is a head of water on it. As the space under the bucket increases the pressure falls in inverse ratio, and when the pressure has been reduced to something less than that in the condenser the foot valve opens, the pressure continues to fall, but the rate is now much less because the clearance has been increased by the condenser volume. This is shown in Fig. 2 where *A B C D* is the clearance, *C D E F* the condenser volume and *A B G H* the volume swept by the air-pump bucket. If the pressure in *A B C D* is 16 pounds absolute at the commencement of the stroke and that in the condenser 2 pounds, the foot valve will not open until eight expansions have been effected; that is, until the bucket has swept through a volume equal to seven times *A B C D*. The clearance volume therefore must not be more than 14½ per cent. of the volume swept by the bucket or the foot valve will not open at all. With 5 per cent. clearance the foot valve would open at approximately one-third of the stroke and the remaining two-thirds would be employed in reducing the pressure in the condenser.

On the downstroke, as the volume below the bucket decreases the pressure increases until first the pressure exceeds that in the condenser when the foot valve closes, and then exceeds that above the bucket when the bucket valve opens. After this the rest of the stroke is occupied in transferring the water and air from one side of the bucket to the other.

The point at which the bucket valve will open depends on the clearance space between the bucket and the head valve. Assuming the weight of water on the valve and the resistance to the opening of the valve itself to be equivalent to a pressure of 1 pound per square inch, it is evident that the bucket valve will not open till the pressure below the bucket is 1 pound per square inch more than that above it. Now the pressure on the underside will approximately retrace the line shown in Fig. 2 while that on the top side will follow a line such as *A B*, *A C* or *A D*, Fig. 3, which corresponds with the clearances between the bucket and the head valve of 5, 7½ and 10 per cent. respectively. In the first case the bucket valve would open at *G*, in the second at *H*, and in the third at *K*, where *X Y* is the stroke.

The action has been followed out as for the air pump pure and simple, but in actual practice an air pump has to deal with water as well as air. This fact is of the greatest importance as by properly arranging the connections the water may be caused to fill the clearance spaces and thus virtually reduce their volume to much less than would be practicable by any other means.

A boiler-feed pump working with a heater, the temperature of the water is an important consideration and limits the vacuum or lift against which a pump will draw, apart from the question of clearance. Suppose it is required to lift the water 12 feet; this is equivalent to pumping against a vacuum of 5 pounds or drawing from a vessel in which the absolute pressure is 10 pounds per square inch. The boiling point at this pressure is 190 degrees so that if the feed water were at a temperature approaching this the pump would not lift it and the pump would become steam-bound. In order to approach the theoretical limits of temperature and vacuum a pump would be required having much finer clearances than the ordinary feed pump, which is constructed chiefly with a view to strength and simplicity.

A. C. WATTS.

Manchester, England.

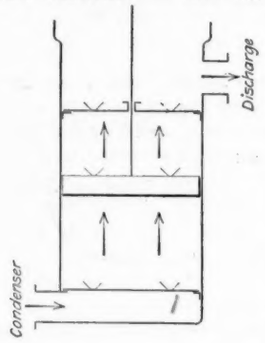


FIG. 1

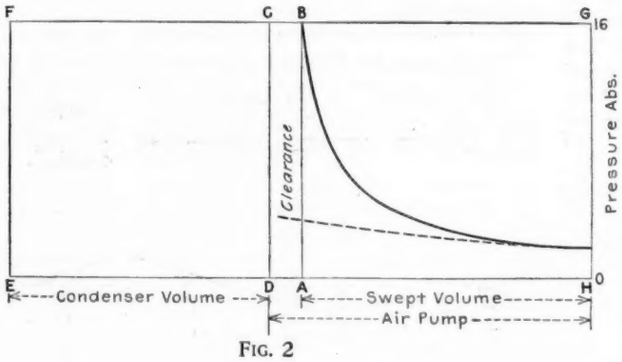


FIG. 2

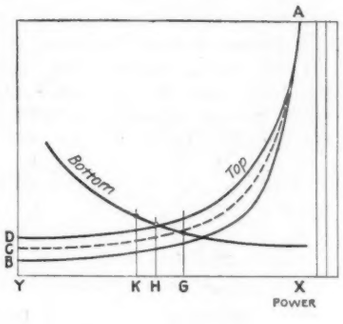


FIG. 3

Sand for Hot Boxes

The advocates of the use of sand to cool hot bearings have not told the readers the why of the remedy, and before trying sand instead of other remedies which are believed to be better, it would be interesting to many to know just why sand will cool a hot box.

It is well known that any abradant, of which sand is a good specimen, when used between two sliding or rolling surfaces will cause friction, and friction in turn produces heat.

If there is a hot bearing, of course it is a case of cause and effect, friction being the cause and heat the effect.

I do not believe that any engineer, as a result of proper experience and knowledge, would use a cause to abolish its own effect.

This reminds me of when I took my first smoke of tobacco. My boy chum told me to take another smoke; it would make me well and I would never be sickened by tobacco again. I was not convinced of his remedy any more than I am now of sand being the proper thing for a hot box.

If conditions will not permit of any other remedy, then sand may be used; it will wear away the babbitt and journal and in this way produce clearance between the journal and the box and allow the oil to flow around the journal. But the sand and babbitt will fill up the oil grooves and then it will be necessary to take the bearing apart, scrap it and cut new oil ways. Sand does not directly cool hot boxes; its effect is indirect.

I always cooled hot bearings by backing off the cap nuts to give more room, then applying more oil and a little graphite, and water if necessary and conditions permitted it. I found that soap and water were very effective as the soap acted as a lubricant while the water carried off the heat by convection, the soap being washed out of the bearing with clean water at the end of the process.

JAMES W. BLAKE.

New York City.

If a box or journal is exceedingly hot, take a thin mixture of graphite and cylinder oil, pour a little into the box and have a can of kerosene handy to pour on to wash out all foreign particles and to cut the gum, should there be any. Cold water can be used providing the box is not too hot; otherwise it will injure the brass or babbitt lining and make it rough. If this is not scraped at the first opportunity it will continue to give trouble. The safest method is to use oil mixed with graphite, enough to just change the color of the oil. Then, use the kerosene as I have stated.

At the first opportunity examine the box and journal and look for the cause of the trouble, for sometimes there may still be an obstacle there to cut and injure the shaft and the box.

I have never tried the sand method, but I think one should have the sand within himself to meet the unforeseen, which oftentimes we are compelled to meet.

W. F. HURD.

Bellefontaine, Ohio.

I have noticed in the recent issues of POWER different engineers' views about sand for cooling hot bearings. Space in POWER is too valuable to be taken up with such a subject. Why not whitewash coal to prevent smoke? A revolving shaft or any piece of metal in motion must be kept separated from its support; naturally this is accomplished with a thin film of oil. If one adjusts a bearing so close that oil cannot get between the surfaces, the surfaces will get too intimate with each other and tend to seize.

A grain of sand of the finest quality is larger in diameter than the thickness of the film of oil between the two bearings and is also harder than the babbitt metal. Naturally the sand will bed itself in the babbitt and cut or scratch the shaft and make it rough. Every engine builder advises in his catalog, the use of a clean, high-grade oil, well filtered. Place the engine in a clean engine room.

We have some valuable sand banks around Danville, but I am yet to hear that the Standard Oil Co. has taken any options on them.

OAKS KYGER.

Danville, Ill.

Air Compressor Running Under

On page 673 of the Oct. 31 issue, John S. Leese gives a number of illustrations showing the directions in which the forces act at the crossheads of different types of air compressors. In Fig. 1 the directions as he gives them hold good only during the first half of the stroke, when the pressure in the steam cylinder is at a maximum and the pressure in the air cylinder is at a minimum. During the last half of the stroke the steam pressure is falling and the air pressure is rising. Now the flywheels give up some of their stored energy and the forces at the crosshead act downward.

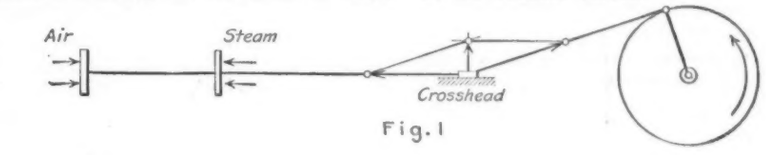


Fig. 1

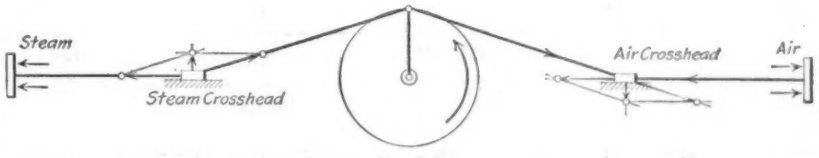


Fig. 2

In Fig. 2 the forces at the air-end crosshead will be upward instead of downward, as the arrow points, and this direction will not change as in Fig. 1, but will always be upward so long as the compressor runs in the direction of the arrow on the crank disk.

GEORGE DREYER.

Gibsonburg, Ohio.

Running Corliss Engine with One Steam Valve

I was interested in C. A. Read's letter published several weeks ago, in which he explains how an engine of the Corliss type was operated for a time with the head-end admission valve removed. He showed an indicator diagram supposed to have been taken from the engine while operating under the conditions described. It appears to me that there is a "screw loose" somewhere, or else all of the contributing conditions and data concerning this test were not given in his letter.

In the first place, I assume that the engine was of the single-eccentric type, with the eccentric set at 90 degrees, plus the angle of advance, in advance of the crank. If such was the case, it would be impossible for a cutoff to occur after the piston had traveled through one-half of its stroke, because the motion of the disengaging link or hook is oscillating and evidently cannot be released by the trip after it has started its return stroke. Therefore, if the load on the engine becomes so heavy that the governor moves the trip so far that it will not be struck by the hook before the reverse motion of the hook begins, release of the hook will not take place at all.

In such a case the admission valve would be closed as if positively connected to the admission crank, the same as the exhaust valves.

Referring again to the diagram, I note that cutoff does appear to take place on the crank end, and that it occurs long after the piston has passed the half stroke. It is also strange that the compression indicated on both the crank and the head end does not appear to be as high as one would expect to find with an engine working under such conditions of high terminal pressure.

Mr. Read states that the engine was started from the usual head-end position. Of course, it would start from that position, as the instant the throttle was opened the full boiler pressure would be applied to the piston direct, thus causing the engine to start. Then, just as the piston reached the crank-end center, the crank-end admission valve would begin to open and admit boiler pressure to that end, and at the same time as the piston started its return stroke, the head

end exhaust valve would open and allow the steam to blow direct through the cylinder from the steam main to the exhaust pipe. Then, as the piston neared the head-end center, the head-end exhaust valve would close for compression, thus allowing no further escape of live steam which, with the head-end steam valve out, would always be present at boiler pressure in the head end. Consequently, a balanced condition would be effected, which would mean as much, or perhaps more, pressure on the head end than on the crank end, because the crank-end steam valve would be closing as previously described, which in turn would be cutting down the steam supply to the crank end and would therefore probably bring the engine to a stop, since the speed attained in one revolution would hardly be sufficient to store enough energy in the flywheel to carry the crank over the head-end center.

H. B. BALL.

San José, Cal.

C. A. Read, in a recent issue, showed an indicator diagram taken with the admission valve removed from the head end. When the head-end exhaust valve opens, the steam rushes straight across the steam chest to the exhaust passage; therefore the back pressure is reduced somewhat below the pressure in the steam chest on the forward stroke and some work is done in that end.

If the exhaust valve should be disconnected and fastened shut, there would simply be a pumping of steam into and out of that end of the cylinder, with no work done aside from that due to friction of the steam in the steam passage.

In the issue of Feb. 2, 1909, there is a letter from me showing the effect upon the steam distribution in the low-pressure cylinder of a cross-compound Corliss engine, because the exhaust valve in one end had been put in upside down. This had just the same effect as though the exhaust valve were disconnected and fastened shut.

A. L. WESTCOTT.

Columbia, Mo.

Some time since there was an interesting letter in POWER from C. A. Read about running a Corliss engine with the head-end valve removed.

Mr. Read asks if the engine would run with the other steam valve removed, and, if so, what would be the appearance of the diagrams secured under those conditions.

I believe the engine would start itself and run with the other valve removed if the exhaust valves were not interfered with, for, although Mr. Read says the engine could not be started by admitting steam to the crank end, I believe it would have started had the crank-end valve been removed also. Then the crank port would have been wide open the same as the head port, with the crank exhaust valve closed and the head exhaust valve wide open; thus the steam pressure on the head end would have been reduced below that on the crank end due to its blowing right through the cylinder into the exhaust.

If Mr. Read's diagrams were taken with an 80-pound spring, there was a difference of about 40 pounds pressure between the forward and return strokes of the piston on the head end. This variation of pressure was accomplished entirely by action of the exhaust valve, the steam port remaining wide open throughout the revolution.

Consequently, I would expect the engine to run with both steam valves removed and to carry some load. It should produce a diagram from the crank end similar to that of the head end, as shown by the figure in Mr. Read's letter.

CHARLES F. CLARK.

Hartwick, N. Y.

Burning Fuel Oil

Replying to D. A. Steiner's query in the November 7 issue, I offer the following:

While at a mine in Arizona two years ago I altered the furnace of a return-tubular boiler in accordance with a plan described in POWER some 2½ years ago.

I sealed the grates with mortar three-quarters of the way back, then laid pieces of light track rail over them as a support for a flooring of firebrick. This in turn was plastered with fireclay from the bridgewall forward, leaving the opening at the front.

Two other plans were tried on this furnace while I was there, but this one gave the best results as to fuel economy and ease of handling the fire. We used the Wilgus burner.

I do not remember the quantity of oil burned per horsepower-hour.

ROBERT LAPSLY.

Ohio, Colo.

In answer to D. A. Steiner's question in the November 7 issue regarding an approved method of burning fuel oil, I would suggest the following, which is in use where I am employed and is giving good results:

The gratebars are removed and the firebox lined with one layer of firebrick. The bridgewall projects about 6 inches toward the front. The firedoors and ashpit doors are built in with firebrick, forming a lattice work. The burner throws the oil in at an angle to the bottom of the ashpit. There are about 75 loose firebrick on the bottom of ashpit where the oil strikes and ignites. One cannot burn fuel oil economically with the ashpit doors entirely closed where steam is used for atomization. I operate with the ashpit doors open about two inches and the damper about two-thirds closed, and we get satisfactory results. I could not tell the amount of oil burned per kilowatt-hour as we have an ice machine taking steam from the same boilers. We used 4½ tons of good coal in 24 hours when using coal and now we use about 570 gallons of fuel oil; I think this is a good showing.

ANDREW BLAIR, JR.

Norborne, Mo.

Graft

It is a good thing for engineers of experience to caution the beginners and advise the owners of the pitfalls encountered by the men shouldering the responsibility. To show how some fall without any opportunity of self-defense, how various schemes are devised to make a market for useless articles and how the dishonesty of a few has thrown discredit on many, I will relate the following incident which came within my own experience:

When I received my first position as chief engineer a friend congratulated me, saying: "The salary may not be the best, but the graft is fine." At first I did not comprehend his full meaning, but after being in my new position about three weeks the owners requested me to test out a new apparatus which had been installed on trial. The sales agent for the apparatus gave me some fatherly advice and told how important it was that I report it favorably.

The machine worked fine and I was inclined to believe everything was as represented, but that night I found a hundred-dollar note in my vest pocket. Then the question arose, "How did it get there?" Naturally I remembered that the agent was the only person who could have done such a thing. He had also taken a cigar out of my pocket and asked me to smoke one of his; then told me to have a good time.

Well, there had been no witnesses but I concluded that he certainly must be a fool to throw away a hundred-dollar bill if his apparatus was as represented. Then it occurred to me that this must be graft, and I resolved to return the money the following morning and get a receipt for it. Fourteen days later the apparatus broke down beyond repair and the manufacturers had to take the machine back. One can imagine what would have happened if the hundred dollars had been spent in having "a good time." Another engineer told me that his superintendent had purchased one of those machines but that he could not see any good in it as it was constantly out of order. Of course he could not, but I could, and whenever I see the man I wonder how he spent his hundred.

Another case which I know of is a company manufacturing electrical ap-

paratus, which makes a practice of sending in two bills upon filling each order; one bill covers the actual price and the other the listed price. The superintendent forwards the latter to the office for payment and takes the former back to the electric company and collects the difference as his commission.

J. H. WHITE.

New York City.

In the November 14 issue, William J. Massey mentioned engineers' wages, graft and a kind of advertising in the selling section of POWER.

POWER goes on record as being opposed to graft in any form, and I believe most any engineer would kick a salesman out of his engine room were he to offer him a rake-off on an order. No honest salesman will try to bribe an engineer and the engineer ought to know there is something wrong with the goods when a bribe is offered.

Of course, some men will accept and some will demand a percentage, but he pays double what he gets back in overtime work and worry.

As to the class of advertising referred to, it leads one to suspect that the advertisers have been guilty of offering bribes or they would not know so much about the evil. In the issue of February 8, 1910, the substitutor was called a mean cuss and was accused of trading on another's reputation and of imitating the several articles used. A man should sweep around his own door before trying to clean up elsewhere.

I do not see anything in the advertising that would insult anyone; on the other hand, it is really amusing that one should try to hide his own misdeeds as an imitator by hurling the charge of graft at the engineers. Who is the better, the grafter or the man who trades on the other fellow's reputation?

H. B. ADCOCK.

Newnan, Ga.

Effective Pressure of a Screw

In the November 14 number, G. P. P. asks for a means of computing the effective pressure of a screw.

The weight that can be raised by a screw, when friction is neglected, is estimated as follows:

$$W = \frac{6.2832\,Pr}{p}$$

where

W = Weight raised or force exerted by the screw;
P = Force applied to the end of the lever;
p = Pitch;
r = Distance from the axis of the screw to the point on the lever where P is applied.

Owing to the friction between the nut and the screw, the weight that can be raised is much less than if friction could be eliminated.

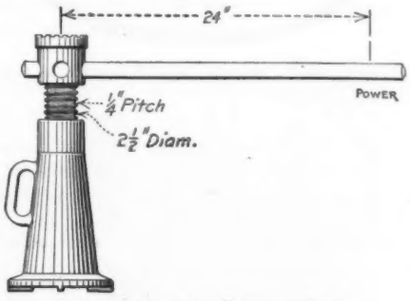
A formula has been made up from a long series of experiments by Wilfred Lewis to find a factor by which to multiply the theoretical load, to find the actual load raised. This formula is as follows:

$$E = \frac{p}{p + d}$$

where

E = Factor by which to multiply the theoretical load to find the approximate load raised;
p = Pitch in inches;
d = Diameter of screw in inches.

For example, it is required to find the load that may be raised by a screw jack having the dimensions given in the accompanying sketch:



DIMENSIONS OF SCREW JACK

Making use of the first rule, it is found that the theoretical load is

$$\frac{6.2832 \times 40 \times 24}{\frac{1}{4}} = 24{,}127.48 \text{ pounds}$$

which could be lifted were it not for friction.

Using the second rule, the factor in this example is

$$\frac{\frac{1}{4}}{\frac{1}{4} + 2\frac{1}{2}} = 0.0909$$

The theoretical load multiplied by this factor will give the approximate load that can be raised by a jack of those dimensions and under those conditions.

$0.0909 \times 24{,}127.48 = 2193.18$ *pounds* real load.

FRED L. WAGNER.

Chicago, Ill.

A Twenty Four Hour Log

C. R. Ward asks for criticisms of his 24-hour log-sheet report, as published in the November 7 issue. Although the generator load is light, the boilers are working at a fair load, 84 per cent. of their rated capacity.

The 462 boiler horsepower equals 11,088 horsepower-hours per day and costs $66.39, or 0.6 cent per horsepower-hour, which is very low. Figuring the probable kilowatt output from the boiler horsepower if the total boiler horsepower was used in the turbine, assuming 75 per cent. of the boiler horsepower delivered to the busbars, the cost per kilowatt-hour would be about 1.1 cents.

Of course, this does not include the fixed charges which if added would keep the cost at a very good figure. His evaporation of 11 pounds of water per pound of coal is good, as the water enters the economizer at 60 degrees so that all the heat in the steam comes from the coal fired in the boiler. The percentage of ash or refuse is a little over 9 per cent., which is very good.

Taking everything into consideration, this is above the average for a 500-horsepower plant. The central-station people do not want a live-steam load and if Mr. Ward can gradually increase his generator load he need have no fear of the central-station man; in fact, this is the type of plant that the central-station people keep clear of. Let us hear from more of them.

J. CASE.

Hyattsville, Md.

Trouble with Leaking Tubes

In the Nov. 21 issue, Charles Fenwick draws attention to the letter of William Beaton in the Sept. 5 issue. I believe a feed-water pipe should enter the front head, extend three-parts the length of the boiler, cross over and drop down between the sheet and the tubes and in no case aproach a seam. If the pipe begins to scale up internally, the boiler attendant will quickly know it before there is any danger, for it will show in the length of time taken to feed in a certain height or quantity of water. The proper procedure is to remove the pipes inside the boiler at the regular boiler-cleaning time, clean the scale from them and connect again. It is a small job to remove and connect such a feed pipe after the first installation.

I am a little skeptical as to the cause given by William Beaton for the cracks at the rivet holes, having seen many boilers which have been in use 15 years and more, with the feed through the blowoff pipe and nothing serious ever happened to them. I do not advocate this method of feeding as there are better ways just as easy to install.

Probably the boiler sheet was burned (as he states that it was badly scaled) or had at least become overheated, thus cracking the scale and allowing some water to reach the hot plate; in this case rapid contraction would do the rest.

William Fenwick's improved system for delivering feed water to a boiler is very old; there are boilers in Toronto which have practically the same system and have had for many years. The idea has been used in boilers which were removed 10 years ago, on account of old age.

However, there is no doubt that such a scale-catching box is an improvement over a pipe simply extended down through the tap sheet, as many of them are, and engineers could do worse than try the idea as suggested.

JAMES E. NOBLE.

Toronto, Ont.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Cement for Glass Oil Cups

What is a good cement for fastening glass into oil cups?

L. S. S.

A good cement for this purpose is made by mixing litharge and glycerin into a stiff paste. It will resist the action of oil and acid and it is insoluble in water. Another cement can be made of ylaster of paris and sodium silicate (water glass).

Safety Valve Rule

Give a rule to determine the weight required to load a given safety valve.

M. J. B.

First. Measure the diameter of the valve (if it is not known) and figure its area (diameter × diameter × 0.7854).

Second. Weigh the valve and its spindle. If this is impossible, compute their volume in cubic inches.

Third. Weigh the lever or obtain its weight f m its dimensions.

Fourth. Obtain the position of center of gravity of the lever by balancing it over a knife edge or some sharp-cornered article and measuring the distance from the balancing point to the fulcrum.

Fifth. Measure the distance from the center of the valve to the fulcrum.

Sixth. Measure the distance from the fulcrum to the center of the weight.

Then compute the required weight as follows:

First. Multiply the pressure in pounds per square inch (at which the valve is to be set) by the area of the valve in square inches. Call this quantity No. 1.

Second. Multiply the weight of the lever in pounds by the distance in inches of its center of gravity from the fulcrum; divide the product by the distance in inches from the center of the valve to the fulcrum, and add to the quotient the weight of the valve and spindle in pounds. Call this quantity No. 2.

Third. Divide the distance in inches from the center of the valve to the fulcrum by the distance, also expressed in inches, from the center of the weight to the fulcrum; call this quantity No. 3.

Subtract quantity No. 2 from No. 1 and multiply by No. 3, and the product will be the required weight in pounds.

Current Consumption of Electric Heaters

If an electric heater requires 10 minutes to bring its temperature up to maximum and is kept in circuit for 10 minutes longer, which period would consume the most energy?

A. L. F.

As the resistance of the wire increases as its temperature rises, it will consume less energy during the second 10 minutes because the resistance is higher.

Contents of Tank

How much oil is contained in a tank 8 feet in diameter and 20 feet long when the level of the oil is 23 inches from the bottom, the tank lying horizontally? How is it computed?

T. P. M.

Divide the rise or hight of the segment of the head covered by the oil (23 in this case) by the diameter, $23 \div 96 = 0.24$.

In a table of "Areas of Circular Segments," such as are to be found in any of the better class of engineers' reference books, find the area corresponding to this quotient. That corresponding to 0.24 is given in the table as 0.14494. Multiply this by the square of the diameter and the product will be the area of the segment.

$$96 \times 96 \times 0.14494 = 1335.8 \text{ } \textit{square inches}$$

This is the cross-section of the body of oil, which is 25 feet, or

$$12 \times 25 = 300 \text{ } \textit{inches}$$

long. Its cubic contents would be

$$300 \times 1335.8 = 400{,}740 \text{ } \textit{cubic inches}$$

or, since there are 231 cubic inches in a gallon,

$$400{,}740 \div 1734.8 \text{ } \textit{gallons}$$

Crank Case Compression

What is the object of compressing in the crank case of a gasolene engine working on the two-stroke cycle and how high should the compression pressure be?

J. A. McC.

The charge must be compressed either in the crank case or in a separate pump cylinder in order to force it into the engine cylinder when the port is opened. Read the article on "Gas Engine Cycles," page 404, of POWER for September 12, 1911. The crank-case compression pressure is usually 5 to 8 pounds per square inch above the atmosphere.

Frequency, Voltage and Speed

What are the relations between the frequency and voltage of the supply circuit and the speed of an induction motor?

B. B. H.

The no-load speed, in revolutions per *second*, is equal to the frequency divided by one-half the number of magnetic poles per phase in the stator. With a load the speed drops somewhat, like that of a direct-current motor.

The voltage does not affect the speed unless it falls so low that the torque (which varies with the square of the voltage) is not sufficient to overcome the "pull" of the load. At this point, the motor "breaks down" and comes to standstill.

Feed Water Entrance to Manning Boilers

Why does not the feed-water pipe in the Manning boiler enter the water leg?

A. L. K.

The feed water enters the Manning boilers as it should all vertical boilers, well up toward the top to give the dissolved air in the water a short path to the steam space, where it cannot do harm by hastening corrosion.

Engine Compression

Is it necessary to change the exhaust valves on a Corliss engine when making a change from noncondensing to condensing?

P. C.

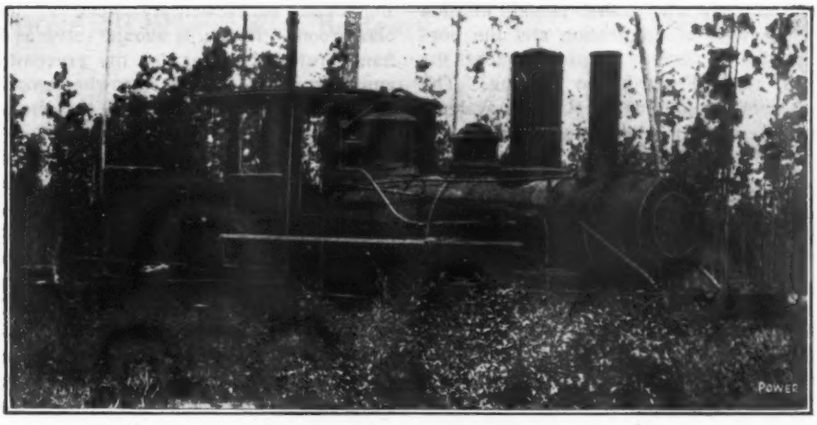
The pressure to which an engine compresses depends upon the pressure at the time the exhaust valve closes. If the valve is closed with a back pressure of 15 lb. absolute, that is, running the engine noncondensing, and that 15 lb. is compressed into one-quarter of the volume which the piston inclosed when the exhaust valve closed, there will be an absolute pressure of 60 lb. If with the exhaust valve closing at the same point there were an absolute pressure of only 2 lb. in the cylinder, there will be an absolute pressure of only 8 lb., and the compression line would not run up to the atmospheric. If there is considerable compression with the condensing engine, it will be excessive when the engine is run noncondensing.

What Means the Dome?

By A. G. Knight

Out in the woods of a certain Southern State there stands a little narrow-gage logging locomotive. It has evidently been deserted for some time as the vines and shrubs are doing their best to conceal it.

It is not an unusual sight to see these diminutive "log-pushers" braving the elements, trying their best to hold themselves together after their work has been accomplished and the lumbermen have pulled up stakes for other fields. But if one looks closely at the illustration he will quickly discover, just back of the stack, a dome-shaped structure that is most unusual to the conventional logging-camp locomotive.



Southern Logging Locomotive

Some of the old-timers in the environs of the little "pusher" were asked to explain the purpose of this dome. While they were considerably surprised that "an engineer from the No'th could not tell right quick what the ornery thing was put to," they were obliged to admit that "we'uns, suh, ain't nevah seen its like befo'. We kain't tell you-all nuthin' 'bout this yere ingine."

Perhaps some reader of Power has seen such a dome on a locomotive and will explain its purpose?

Power Show at Boston

In conjunction with the textile exhibition, to be held in Boston at the Mechanics Building from Apr. 22 to 27 by the Textile Exhibitors' Association, a power show will be given under the auspices of the New England Association of Commercial Engineers.

The power exhibition will include the exhibition of all kinds of power-producing and transmitting machinery, accessories and supplies. During the same week the national exhibition of textile machinery and mill supplies will be held under the auspices of the Textile Exhibitors' Association; also the convention of the National Association of Cotton Manufacturers will be held during two days, and the Master Mechanics' Association of America will hold its convention, educational meetings and a general mass meeting of master mechanics.

Personal invitations will be sent to 10,000 chief engineers, master mechanics, consulting engineers and others directly connected in the installing, buying and specifying of power-producing materials.

The power show gives manufacturers and dealers an excellent opportunity to show their products.

About 80 spaces are for sale, and preference in allotment of spaces will be given to firms represented in the membership of the New England Association of Commercial Engineers.

I. O. E. Bulletin Binders

A durable binder, suitable for preserving the headquarters bulletin of the Institute of Operating Engineers and similar publications, may be secured upon application at the offices of the Institute, 29 West Thirty-ninth street, New York City.

The price is 55 cents, postpaid. For 45 cents additional, the member's name and the name of the Institute will be stamped thereon in gold letters.

Chicago Engineers' New Home

Located at 314 South Federal St., the new clubhouse of the Chicago Engineers' Club is most convenient of access. The building, of which the club has a 99-year lease, occupies a lot 25x100 ft., and when remodeled it will be seven stories high, of brick and mill construction.

In leasing the first three floors to a grill company, satisfactory arrangements were made whereby the club will be served with excellent meals on its own premises at satisfactory prices.

The fourth floor has coat and toilet rooms, a reception and lounging room, with a large open fireplace; and a card room. The fifth floor will ultimately be used for billiard and club rooms. The sixth and seventh floors are to be subdivided into bed rooms, seven bed and bath rooms on each floor. In the basement is located the heating plant.

Good taste has been displayed in the selection of the decorations and furnishings. It is expected that the new investment will give a comfortable surplus within a decade.

N. E. L. A. Has Over 10,000 Members

At the meeting of the executive committee of the National Electric Light Association, on Dec. 7, it was announced that the membership had that day reached 10,000 and was, in fact, very nearly 10,150. Up to July, 1909, the membership of the association was still below 3000, but the last two years have been periods of unprecedented expansion and there are many indications that the end is by no means yet, as the present growth is equal to anything experienced in the history of the association. The work of the association is broadening out in every direction, and the official headquarters in the Engineering Societies Building are undergoing equal expansion, four additional rooms having been taken within the past three months, so that the space now occupied is virtually as great as that occupied by any one of the three founder societies.

SOCIETY NOTES

The Institute of Operating Engineers has been unable to fill five vacancies, ranging in salaries from $1800 to $2600 a year, because of its inability to find suitable men to fill them.

The annual meeting of the American Society of Heating and Ventilating Engineers will occur at the Engineering Societies building, 29 West Thirty-ninth street, New York City, on January 23, 24 and 25, 1912.

The ten combined associations of Manhattan and Bronx of the National Association of Stationary Engineers will hold their annual entertainment and reception at Terrace Garden, New York, Saturday evening, December 30.

The Combined Associations of Engineers of Brooklyn at their annual meeting elected the following officers: Past chairman, William Smith; chairman, George Roff; vice chairman, Charles Schwabacker; corresponding secretary, Walter Brundage; financial secretary, Charles Eingren; treasurer, George O. Kaley; sergeant at arms, James Starrett. The Combined Associations comprise the following associations: National Association of Stationary Engineers Nos. 8, 27, 41 and 57, Brooklyn Councils Nos. 8 and

9, U. C. C. of E., Modern Science Club. The annual entertainment and reception will be held at Kismet Temple, February 21.

PERSONAL

S. B. Redfield, formerly associate editor on the staff of the *American Machinist,* has accepted a position with the Ingersoll-Rand Co., and will act in the capacity of engineer of tests at its Phillipsburg, N. J., plant. Mr. Redfield was connected with the engineering department of the Ingersoll-Rand Co. prior to his editorial experience.

G. Tisell, of the editorial staff of the *Electrical World,* has been appointed secretary of the Captain John Ericsson Memorial Society of Swedish Engineers. The objects of the society are to honor the memory of John Ericsson and to promote the interests of Swedish engineers. The society, which now has about 150 members, is actively engaged in collecting articles of all kinds which in any way relate to John Ericsson's work.

NEW PUBLICATIONS

POWER. By Prof. Charles E. Lucke. Published by the Columbia University Press, New York, 1911. Size, 5x7½ inches; 316 pages; 223 illustrations; cloth. Price, $2 net.

The book is compiled from a set of lectures by the author, tracing the development in power machinery within the past hundred years, and pointing out the enormous strides that have been made within the last few years. The effect of this development upon the organization of society and the conditions of living is shown, with special reference to the substitution of power for manual labor in manufacturing industries and the improved methods of transportation and communication.

Special chapters are devoted to fuels, water-power systems, efficiency in steam-power and gas-power systems. In connection with the latter subject it may be mentioned that much of the material has been taken from Cecil P. Poole's "The Gas Engine," for which the author has neglected to give credit.

The text combines the historical with a general view of the present status of power development. It is written in popular style and should prove interesting not only to the engineer but to those outside the profession.

PRINCIPLES OF INDUSTRIAL ENGINEERING. By Charles Buxton Going. Published by McGraw-Hill Book Company, New York, 1911. Cloth; 174 pages, 6x9 inches. Price, $2 net.

Industrial engineering or efficiency engineering, as it is popularly called, is one of the newest sciences. Its development is one of the results of the great expansion that has been and still is taking place in the manufacturing world. It is the science of "making two blades of grass grow where one grew before," of making two carpet tacks or two locomotives for what it formerly cost to make one. In short, it is the science of making the best use of material, effort and money.

Being a new science, much has been written and uttered about it that is useless and misleading, tending to exaggerate the true value of its application in certain directions. The present book, however, is dignified and moderate. The author does not presume to pronounce the last word on any phase of the broad subject of which he writes. His aim is to lend the reader a true perspective of the entire field.

To anyone who desires to gain an idea of the field of application and the possibilities of scientific management the book is well worth the reading. The chapters on the various wage systems and the management of labor are by far the most interesting.

HYDRAULIC TURBINES: THEIR DESIGN AND INSTALLATION. By Viktor Gelpke and A. H. Van Cleve. Published by the McGraw-Hill Book Company, New York, 1911. Cloth; 293 pages, 7x9 inches; 200 illustrations. Price, $4 net.

In view of the fact that it has been within only the last score of years that water power has been recognized as one of the world's most important resources and developed to any extensive degree, it is not surprising that there is a dearth of literature in English on the subject. The present book seems to fill a genuine need, covering, as it does, the entire subject of the mathematical design of both water turbines and impulse wheels.

The book is divided into three sections. The first is entitled, "Turbines and Their Accessories." It deals with such subjects as the designs of and materials for pressure pipes, draft tubes, valves, gates, racks, etc. The final chapter of the section deals with the general design of the various forms of water turbine together with speed and pressure regulators. Some portions of this first section are fundamental and for that reason should be valuable to the student and general engineering practitioner.

The mathematical design of turbines of all types is contained in the second section. Several numerical examples have been completely worked out to illustrate the various steps in the design and the use of the proper formula.

The last section of the book contains the description and illustration of several representative water-power plants in America. The plants described have been selected with the idea of showing the various forms of development.

PRACTICAL THERMODYNAMICS. By Forrest E. Cardullo. Published by the McGraw-Hill Book Company, New York, 1911. Pages, 411; illustrations, 224; size, 6x9 inches; cloth. Price, $3.50 net.

In the preparation of this book the author has held to a physical rather than an abstract treatment of the subject and has introduced a minimum of higher mathematics. In the latter connection such mathematical formulas as are used, are developed in a logical manner. All definitions are stated as simply as possible, and in all, except plainly obvious cases, are illustrated by concrete applications.

Although intended primarily as a textbook for use in technical schools, it is not dependent for its proper understanding upon supplementary work in the class room. Hence, it should serve as a handy reference book for the practising engineer. The text is somewhat amplified by a set of problems with answers at the end of each chapter.

The subject of entropy is treated in a separate chapter upon which no other part of the book is dependent. The material in this chapter, however, is arranged so that it parallels the remainder of the book; hence, this method of analysis may be applied wherever desired.

Chapters are given describing and illustrating the various apparatus that goes to make up the equipment of the modern power plant. In this respect it is to be regretted that more space was not devoted to the treatment of the steam turbine.

Considered as a whole, however, the book is instructive and well written.

BOOKS RECEIVED

PHYSICAL AND CHEMICAL CONSTANTS. By C. W. C. Kaye and T. H. Laby. Longmans, Green & Co., New York. Cloth; 153 pages, 6½x9¾ in.; indexed. Price, $1.50.

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK FOR 1912. Emmott & Co., Ltd., Manchester, Eng. Cloth; 3¾x6 in.; illustrated; tables; indexed. Price, sixpence.

ELEMENTARY APPLIED MECHANICS. By Arthur Morley and William Inchley. Longmans, Green & Co., New York. Cloth; 382 pages, 4½x7½ in.; 261 illustrations; tables; indexed.

THERMODYNAMICS OF THE STEAM TURBINE. By Prof. Cecil H. Peabody. John Wiley & Sons, New York. Cloth; 282 pages, 5¾x9 inches; 103 illustrations; indexed. Price, $3.

THE TESTING OF MOTIVE POWER ENGINES. By R. Royds. Longmans, Green & Co., New York. Cloth; 396 pages, 5½x8¾ inches; 193 illustrations; conversion tables; indexed. Price, $3.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

We have been asked what good came of the convention of advertising men in Boston.

Of course, there were many tunes played, but the note that was heard above all others was honesty.

Honest, straightforward advertising has the right of way.

Over 2000 business men—buyers and sellers—from all over this continent and England, so declared themselves.

They demanded that everyone who wants the respect of other sellers, who wants the business of the buying public, must play fair.

That's the handwriting on the wall.

Selling practices that have heretofore been passed over in silence, if not condoned, must stop.

The fraudulent, lying advertiser is an outlaw and will be so regarded.

The crook will find his doom under the steam roller of progress.

One speaker said:

"For two years and more we have steadfastly held to a purpose. That purpose is to educate the advertisers of this country that there is but one kind of advertising that will be permanently profitable and that is honest, truthful advertising. And at the same time we are endeavoring to teach the American people the believableness of advertising and forever stamp out the stigma of untruth, which is so often applied to advertising, and banish from the minds of the people the thought that an advertisement of a corporation or firm is in any degree less reliable than its signed statement."

Another result is a movement on foot to have a national law for the repression of dishonest advertising.

Mayor Gaynor, of New York, on November 10, wrote to the editor of *Printer's Ink* referring to this:

"I have read the proposed statute which you inclose to me and I can see no reason why it should not be adopted. To publish false and misleading statements in advertisements ought to be a criminal offense. Of course the business of advertising is now reduced almost to a science and the great majority of advertisements are truthful."

That's the kind of advertising in these columns. No false statements can appear if we know it.

* * *

Only reliable products can be continuously advertised.

NEW EQUIPMENT

Southampton, Ont., will buy an electric pump.

Exeter, Ont., will equip a hydro-electric station.

Salmon, Idaho, voted $65,000 bonds for water-works.

Victor, B. C., will build a new water-works plant.

Beachville, Ont., will spend $46,000 on electric equipment.

Holt Kain will build an artificial-ice plant at Liberty, Ind.

St. Mary's, Ont., voted $15,000 for power-house equipment.

Gold Hill, Ore., has voted bonds for $25,000 for water-works.

Galt, Ont., will call for bids on centrifugal pumps and motors.

Pacific, Mo., will issue $15,000 bonds for improving its water-works.

The Saskatoon (Sask.) Milling Co. will install an electric power plant.

Montcalm, Que., will buy a 12,000,000-gal. steam pump and an air pump.

Melrose, Mass., will issue $5000 for improvements to its water system.

The City Ice Co., Baltimore, Md., will erect a new plant on the Falls road.

The Bayshore Development Co., Tampa, Fla., will construct water-works.

Orange, N. J., will issue $13,000 bonds for improvements to its water system.

Woodstock, Ont., will spend $10,000 for additional electric-lighting equipment.

A. F. Connor will install a boiler at 43 South Cruse St., Indianapolis, Ind.

Brockville, Ont., will purchase additional water-works pumping machinery.

Akron, Ohio, will issue $160,000 bonds for improving its water-works system.

The Stadaema Hydraulic Co. will build a new power plant at Seven Falls, Que.

Fire destroyed the power house of the Jas. Leo Paper Box Co., Jersey City, N. J.

Royersford, Penn., voted $30,000 for installing a municipal electric-light plant.

Aransas Pass, Tex., voted $15,000 bonds for electric-light plant and water-works.

The Gleason (Tenn.) Water & Light Co. will install an electric-light plant.

The power plant of the Brown Rubber Co., Providence, R. I., was destroyed by fire.

The plant of the Milton & Milton Junction Gas Co., at Milton, Wis., will be rebuilt.

The American Sheet & Tin Plate Co., Cleveland, Ohio, will erect a large boiler house.

The American Sheet & Tin Co., Cleveland, Ohio, will build a gas-producing plant.

Geo. H. Clemence, Southbridge, Mass., will install a small boiler and a gasoline engine.

Hamilton, Ont., is asking for bids for the construction of an electric substation.

The De Witt Wire Cloth Co., Belleville, N. J., will install new engine and boilers.

Osceola, Ark., contemplates the construction of water-works to cost about $30,000.

The Eastern Canada Power Co., Montreal, Canada, will equip a new power plant.

Hermiston, Ore., will issue $25,000 bonds for improvements to its water system.

The H. H. Mayhew Co., Shelburne Fals, Mass., will install ten new electric motors.

The city of Philadelphia, Penn., is having plans prepared for a new large power plant.

Webster Grove, Mo., will issue $75,000 bonds for improvements to its water system.

The Baltimore & Ohio R.R. will build a new power plant at its Zanesville, Ohio, shops.

The Fort Worth (Tex.) Southern Traction Co. is planning to erect three new substations.

Convoy, Ohio, voted to install a municipal electric-light plant. W. F. Henney, village clerk.

Cramp & Co., Philadelphia, Penn., have plans for a power plant at Front and Allegheny Aves.

The New South Brewery & Ice Co., Middlesboro, Ky., will rebuild its plant recently burned.

Mountain Grove, Mo., is considering $25,000 bond issue for the construction of water-works.

The Union Ice Co., Boca, Calif., is planning the erection of a $500,000 electric power plant.

The Magog (Que.) Power Co. will equip a $125,000 hydro-electric plant on the Magog River.

The Greenville (Ohio) Electric Light & Power Co. will need some new power-house equipment.

The power plant of the United States Express Co., at Jersey City, N. J., was destroyed by fire.

The Elbow River Power & Development Co., Calgary, Can., will equip a new power plant.

Lamar, Mo., will issue $70,000 bonds for improvements to its water system and lighting plant.

Geneva, Ill., will ask for bids on engine, generator, boiler, etc., for the electric-lighting plant.

The J. J. Buckley Co., Cleveland, Ohio, will need some power equipment for its new cloak factory.

The Lanton Mills Corporation, Plainfield, Conn., is to install electricity throughout its plant.

Drummondsville, Que., will purchase new power machinery, including generator, waterwheel, etc.

Fire destroyed boiler plant, engine room, etc., at the El Grove (Calif.) Winery. Will be rebuilt.

The Pendleton (Ore.) Meat Co. is planning the erection of a new meat-packing and cold-storage plant.

Ferguson Brothers Manufacturing Co., Hoboken, N. J., will install two new boilers, generators, etc.

The Castlerock (Wash.) Coal, Light & Power Co., is having plans prepared for an electric power plant.

Cookeville, Tenn., voted $30,000 bonds for extending and improving its electric-light and water plants.

Swift & Co., First and Santa Fé Sts., Los Angeles, Calif., will make addition to their cold-storage plant.

The Knickerbocker Ice Co. will erect a one-story ice factory at 638-46 West Sixty-fifth St., Chicago, Ill.

The Lamson & Goodnow Co., Shelburne Falls, Mass., will install 14 new electric motors in its plant.

An addition wil be built to the boiler house of J. C. Frasch, at Erie and Salmon Sts., Philadelphia, Penn.

The board of control, Montreal, Canada, will equip a municipal refrigeration plant for Bonsecours market.

Fire destroyed the substation of the Noblesville Heat, Light & Power Co., at Arcadia, Ind. Will be rebuilt.

The Schlegelmaier Brewing Co., Wilkes-Barre, Penn., will erect a five-story building to cost $250,000.

The Paragould (Ark.) Electric Light & Power Co. will build an addition and install new dynamo and engine.

The Eagle Ice Co. will build a $12,000 addition to its plant at Fifty-seventh and Hoffman Sts., Philadelphia, Penn.

The Edison Illuminating Co., Detroit, Mich., has increased its capital and will spend $1,500,000 for improvements.

The Defiance (Ohio) Utilities Co. will be in the market for electric-light equipment. T. T. Ansberry, manager.

Swift & Co., of Chicago, plan the erection of a cold-storage plant at Lewiston, Mont. G. R. Nelson is in charge.

The citizens of Fort Pierce, Fla., will vote on $15,000 bond issue for the construction of an electric-light plant.

M. S. Gleason and R. E. Fisher, of Mecca, Ind., will build an artificial-ice plant at Hartford City, Ind., to cost $25,000.

The Terminal Freezing & Heating Co., Baltimore, Md., will erect a large addition to its plant on South Eutaw St.

The Citizens Ice & Cold Storage Co., Belleville, Ill., expects to replace its 225-hp. steam engine with gas engine and producer.

The Young Men's Christian Association, Olympia, Wash., will make improvements and additions to its electric-lighting plant.

Otto C. Wolf & Son will erect a five-story brewery and one-story engine house, at Second & Edward Sts., Philadelphia, Penn.

The substation of the Great Shoshone & Twin Falls Light & Power Co., at Gooding, Idaho, was destroyed by fire. Will be rebuilt.

The Fuerza & Ferrocarriles Co., Pachuca, Mex., plans for the erection of a hydro-electric power plant on the Tula River, of about 8000-hp. capacity.

NEW CATALOGS

Nelson Valve Co., Philadelphia, Penn. Pamphlet. Nelson blowoff valve. Illustrated, 5x7 inches.

Bates Machine Co., Joliet, Ill. Bulletin No. 36. Bates inertia valve gear. Illustrated, 8 pages, 6x9 inches.

Oil City Boiler Works, Oil City, Penn. Catalog. Geary water-tube boiler. Illustrated, 50 pages, 3½x6 inches.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SALESMAN — Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AGENTS for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesman Address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

WANTED—By large eastern manufacturer, designer to handle line of high-grade gate valves up to largest size; state experience, salary expected, etc., to "Opportunity," Box 550, Power.

A YOUNG MAN with a technical education and some experience, to handle a number of small steam heating plants; salary to start, $25 per week. Address "C. W. H.," Box 637, General P. O., New York City.

BOILER MEN—Several energetic men who are familiar with the operation of steam boilers can secure good positions as salesmen on straight salary and in good territory; in making application, state age and experience. Address "Boiler," care Power.

AGENTS—To sell lubricating oils, belts, hose, paint and varnish, for power machinery, to factories, mills, auto owners, stores; exclusive territory; oil experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, Ohio.

MECHANICAL SUPERINTENDENT wanted for large concern; must be first-class steam and electrical engineer, draftsman, mechanic, etc.; also possess good executive ability; technical graduate preferred. Charles P. Raymond, 294 Washington St., Boston.

MECHANICAL ENGINEER, one who has had experience in large power-house work and who is capable of directing the layout of power-house work in general. In answer, state age, experience and education. Address "C. W. H.," Box 637, General P. O., New York City.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

BRANCH MANAGER, engineering graduate, will consider position as assistant sales manager; A-1 references. Box 547, Power.

FIREMAN—Middle-aged man, with 15 years' experience firing various types of boilers, wants place where intelligent work will be appreciated. Box 549, Power.

MECHANICAL ENGINEER with technical education and practical shop experience, wants position in South or West preferred, or will go to foreign country. Box 546, Power.

TECHNICAL GRADUATE in mechanical engineering, 24 years old, desires position where there is a good opportunity for experience and advancement; have had some experience in shop and drafting room; references. Box 548, Power.

POSITION as mechanical engineer or superintendent; 10 years' successful practice on large steam and gas engines and general machinery; can design and build high class machinery along these lines; have several hundred engines in successful operation. Box 545, Power.

AFTER JAN. 1 employment wanted either temporary or permanent, by mechanical engineer, trained and with actual experience in most all branches of the business, as practical machinist and operating engineer, as erecting and consulting engineer, as draftsman and shop foreman, as salesman and office man handling correspondence, etc.; have made a study of power house economies; personal interview or correspondence solicited; gilt-edge references as to integrity and reliability; would represent engine, boiler or power-house equipment manufacturer as resident or traveling engineer in this section. Address "Mechanical Engineer," Room 1533, Exchange Bldg., Memphis, Tenn.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS—C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. C. P. Monash, 1417 W. Jackson Blvd., Chicago, Ill.

ENGINEERS OR MANAGERS of steam plants, for a short time the best indicator outfit on the market free with your first order for boiler compound, in powder or brick form; no pay until satisfactory. N. A. Olson Co., Manitowoc, Wis.

I WOULD BE PLEASED to receive catalogs and quotations from firms handling the folowing articles: Steam fitters' supplies, plumbers' supplies, electric supplies, dust-down, plate glass, hardware, laundry supplies, disinfectant, paints and oils. Wm. H. Swope, Chief Engineer, National Orphans' Home, Tiffin, Ohio.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ONE SINGLE CYLINDER, 66 horsepower gas engine and producer; made by the Power & Mining Machry. Co., Avery Scale Co., North Milwaukee, Wis.

8x10 SKINNER ENGINE, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator . Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE 100-HP. KINGSFORD marine boiler, corrugated tube, used only 18 months, guaranteed to pass inspection; one Geary water tube boiler, 100-hp., in first-class condition. G. J. Burrer & Sons, Sunbury, Ohio.

IDEAL, simple engine, 14x14, 125 horsepower at 100 pounds pressure; rebuilt with new Chuse shaft, new piston and valve; in first-class condition; larger engine installed, reason for selling. F. A. Heermans, city clerk, Mattoon, Ill.

ONE HORIZONTAL cross-compound Hamilton Corliss engine, direct connected to a 750-kilowatt, 6600-volt, three-phase, 25-cycle General Electric generator; this unit is in first-class condition, and can be seen running up until January 15. For price apply to Brooklyn Edison Co., 360 Pearl St., Brooklyn, N. Y.

ALPHABETICAL INDEX TO ADVERTISERS

	Page
Albany Lubricating Co.	81
Allis-Chalmers Co.	108
American District Steam Co.	100
American Engine Co.	109
American Injector Co.	92
American Mfg. Co.	89
American Metal Hose Co.	100
American Radiator Co.	85
American Ship Windlass Co.	91
American Steam Gauge & Valve Mfg. Co.	56, 57
Ames Iron Works	106
Anderson Co., V. D.	76
Armstrong Cork Co.	72
Armstrong Mfg. Co.	90
Armstrorg Mfg. Co., The	66
Ashton Valve Co.	68
Austin Separator Co.	74
Babcock & Wilcox Co., The	95
Ball Engine Co.	106
Baragwanath & Son, Wm.	84
Barnes Co., W. F. & John.	88
Beggs & Co., James	82
Bignall & Keeler Mfg. Co.	73
Blake & Knowles Steam Pump Works	86
Bogart Gas Power Engineerin Co.	104
Bowers Rubber Works	94
Bowser & Co., Inc., S. F.	79
Bristol Co.	4th cover
Bruce-Macbeth Engine Co.	104
Buckeye Engine Co.	108
Buffalo Steam Pump Co.	93
Builders Iron Foundry	97
Burt Mfg. Co., The	16
Cameron Steam Pump Works, A. S.	93
Casey-Hedges Co.	95
Chaplin-Fulton Mfg. Co.	97
Chapman Valve Mfg. Co.	70
Chesterton Co., A. W.	79
Columbian Rope Co.	66
Columbus Machine Co.	104
Connersville Blower Co., The	92
Consolidation Coal Co.	13
Cooley & Milligan	72
Cooper Co., C. & G.	105
Crosby Steam Gage & Valve Co.	67
Curtis & Curtis Co., The	71
Dallett Co., Thos. H.	98
Dart Mfg. Co., E. M.	72
Davis Regulator Co., G. M., 4th cover	
Dearborn Drug & Chemical Works	5
Deming Co.	93
Detroit Lubricator Co.	81
Diamond Rubber Co.	94
Dixon Crucible Co., Jos.	79
Elliott Co., 7, 68, 70, 76, 79, 80, 85,	86
Engineers Appliance Co., The	67
Epping-Carpenter Co.	92
Eureka Packing Co.	65, 76
Fitchburg Steam Engine Co.	106
Fort Wayne Electric Wks.	113
Franklin Oil Filter Co.	80
Garlock Packing Co.	9
Graver Tank Works, Wm.	98
Greene, Tweed & Co., 80, 4th cover	
Griffith & Wedge Co., The	108
Griscom-Spencer Co.	87
Hamler-Eddy Smoke Recorder Co.	96
Hammel Oil Burner Co.	91
Harbison-Walker Refractories Co.	99
Harris Steam Engine Co., W. A.	108
Harrisburg Foundry & Machine Works	108
Harrisburg Mfg. & Boiler Co.	97
Harrison Safety Boiler Works	59
Heine Safety Boiler Co.	96
Hewes & Phillips Iron Wks.	109
Hoffman, Geo. W.	105
Homestead Valve Mfg. Co.	70
Hooven, Owens, Rentschler Co.	109
Hoppes Mfg. Co.	88
Hughson Steam Specialty Co.	68
Huyette Co., Inc., Paul B.	66
International Corr. Schools.	63
International Harvester Co. of America	105
Jeffrey Mfg. Co.	64, 75
Jenkins Bros.	61
Jefferson Union Co.	83
Johns-Manville Co., H. W.	67
Keeler Co., E.	96
Kellogg Co., M. W.	72
Kennedy Valve Mfg. Co.	67
Kerr Turbine Co.	101
Kennicott Co., The	97
Keystone Lubricating Co.	3
Lagonda Mfg. Co.	3d cover
Laidlaw-Dunn-Gordon Co., The	103
Liberty Mfg. Co.	7
Locke Regulator Co.	70, 110
Long Grate Bar Co., The	90
Lunkenheimer Co.	4
Lytton Mfg. Corporation	74
McClave-Brooks Co.	12
McGowan Co., The John H.	93
McGraw-Hill Book Co.	112
McIntosh, Seymour & Co.	109
McLeod & Henry Co.	98
Magnolia Metal Co.	110
Main Belting Co.	89
Manzel Bros. Co.	81
Martin Grate Co.	90
Mason Regulator Co.	68
Mietz Iron Fdry. & Mach. Works, August	104
Minneapolis Steel & Machine Co.	109
Monarch Valve & Mfg. Co.	68
Morehead Mfg. Co.	76
Morrin Climax Boiler Co.	96
Murphy Iron Works	91
Nashua Machine Co.	75
National Pipe Bending Co.	85
National Tube Co.	71, 72, 73
National Meter Co.	64
Naugatuck Mfg. Co.	88
Neemes Bros.	90
Nelson Valve Co.	69
New Bedford Valve Mfg. Co.	70
New Process Rawhide Co.	111
New York & New Jersey Lubricant Co.	79
New York Belting & Packing Co., Ltd.	10
New York Edison Co.	82
Newhall Eng. Co., Geo. M.	77
Nicholson File Co.	100
Northern Equipment Co.	94
Nugent & Co., Wm. W.	80

	Page
Ohio Blower Co	88
Ohio Brass Co	97
Ohio Injector Co	68
Oil City Boiler Works	96
Open Coil Heater & Purifier Co	74
Oster Mfg. Co	85
Otto Gas Engine Works	105
Parson Mfg. Co	91
Patterson & Co., Frank L.	86
Peerless Rubber Mfg. Co.	8
Penberthy Injector Co	11
Pennsylvania Flexible Metallic Tubing Co	100
Perfection Grate Co	90
Perkins Co., Jno. B	70
Perolin Co. of America	95
Pierce Co., Wm. B. 2d cover	
Pittsburgh Valve, Foundry & Construction Co	70
Power Specialty Co	80
Precision Instrument Co	66
Providence Engr. Works	105
Quimby, Inc., Wm. E	92
Reliance Gauge Column Co.	98
Richardson-Phenix Co	78
Ridgway Dynamo & Engine Co	109
Robb Engineering Co., Ltd.	91
Robertson & Son, Jas. L.	65
Rogers Co., H. A	88
Rollins Engine Co	107
Rooksby & Co., E. J	110
"S-C" Regulator Co	95
St. John, G. C	93
Salamander Grate Bar Co.	90
Scaife & Sons Co., Wm. B.	98
Schade Valve Mfg. Co	70
Schaeffer & Budenberg Mfg. Co	66
Schieren Co., Chas. A	88
Schuchardt & Schütte	75
Schutte & Koerting Co	110
Sherwood Mfg. Co	81
Short Flexible Stuffing Box Co	74
Skinner Engine Co	106
Smith & Son Co., Samuel	95
Smooth-On Mfg. Co	6
Squires Co., C. E	75
Starrett Co., L. S	88
Steel Mill Packing Co	94
Stewart Co., The Paul	64
Struthers-Wells Co	105
Sturtevant Co., B. F	103
Terry Steam Turbine Co.	66
Toledo Pipe Threading Machine Co	73
Treadwell Co., Inc., M. H.	90
Trill Indicator Co	71
Trimont Mfg. Co	102
Tripp Metallic Packing Co.	94
Turbo-Blower Co	64
Turner Fricke Mfg. Co	104
Uehling Instrument Co	96
Under-Feed Stoker Co. of America	89
Underwood & Co., H. B.	106
Viter Mfg. Co., The	106
Vogt. Mach. Co., Inc., H.	96
Von Kokeritz & Co., R. G.	85
Walton Co., F. S	14, 15
Washburn & Granger	90
Watson & McDaniel Co	93
Watts-Campbell Co	108
Webster & Co., Warren	86
Westinghouse Machine Co.	114
Wheeler Condenser & Engineering Co	92
Wheeler Mfg. Co., C. H	93
Whitlock Coil Pipe Co	71
Wickes Boiler Co., The	96
Williams & Co., J. H	101
Wing Mfg. Co., L. J	64
Wisconsin Engine Co., The.	102
Worthington, Henry R., 1st cover	
Wright Mfg. Co	74
Yale & Towne Mfg. Co	91
Yarnall-Waring Co	73

CLASSIFIED INDEX *to* ARTICLES ADVERTISED

Air Compressors
Allis-Chalmers Co. 108
Laidlaw-Dunn-Gordon Co. 103
Perkins Co., Jno. B. 70
Viter Mfg. Co. 106

Alarms, Low Water
Detroit Lubricator Co. ... 81
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lunkenheimer Co. 4
Penberthy Injector Co. 11
Reliance Gauge Column Co. 98
Wright Mfg. Co. 74

Alternators
Allis-Chalmers Co. 108

Ash Ejectors
Parson Mfg. Co. 91

Belt Dressing
Dixon Crucible Co., Jos. .. 79
Garlock Packing Co. 9
Keystone Lubricating Co. . 3
Robertson & Son, Jas. L. . 65
Schieren Co., Chas. A. 88
Smooth-On Mfg. Co. 6
Walton Co., F. S. 14, 15

Belt Lacing
Bristol Co. ..... 4th cover
Schieren Co., Chas. A. 88

Belting
Bowers Rubber Works 94
Diamond Rubber Co. 94
Garlock Packing Co. 9
Greene, Tweed & Co., 80, 4th cover
Jeffrey Mfg. Co. 64, 75
Main Belting Co. 89
New York Belting & Packing Co., Ltd. 10
Peerless Rubber Mfg. Co. . 8
Schieren Co., Chas. A. 88

Blocks, Chain
Yale & Towne Mfg. Co. ... 91

Blowers, Fan
Beggs & Co., James. 82
Buffalo Steam Pump Co. .. 93
Ohio Blower Co. 88
Sturtevant Co., B. F. 103
Terry Steam Turbine Co. .. 66
Turbo-Blower Co. 64
Wing Mfg. Co., L. J. 64

Blowers, Steam Jet
Beggs & Co., James. 82
McClave-Brooks Co. 12
Parson Mfg. Co. 91
Schutte & Koerting Co. .. 110

Boiler Compound
Dixon Crucible Co., Jos. ... 79
Dearborn Drug & Chemical Works 5
Johns-Manville Co., H. W. 67
Keystone Lubricating Co. . 3
Perolin Co. of America. ... 95
Sherwood Mfg. Co. 81

Boiler Fronts
Casey-Hedges Co. 95

Boiler Setting
Harbison-Walker Refractories Co. 99
McLeod & Henry Co. 98

Boiler Tube Cap Reseating Machine
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co. ... 3d cover
Liberty Mfg. Co. 7

Boiler Tube Cleaners
Chesterton Co., A. W. 79
Dallett Co., Thos. H. 98
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Johns-Manville Co., H. W. 67
Lagonda Mfg. Co. ... 3d cover
Liberty Mfg. Co. 7
Parson Mfg. Co. 91
Pierce Co., Wm. B. .. 2d cover
Robertson & Sons, Jas. L. . 65
St. John, G. C. 93

Boiler Tubes
National Tube Co. ... 71, 72, 73

Boilers
Ames Iron Works 106
Babcock & Wilcox Co. 95
Beggs & Co., James. 82
Casey-Hedges Co. 95
Griffith & Wedge Co. 108
Griscom-Spencer Co. 87
Harrisburg Foundry & Machine Works 108
Harrisburg Mfg. & Boiler Co. 97
Harrison Safety Boiler Works 59
Heine Safety Boiler Co. ... 96
Hewes & Phillips Iron Wks. 109
Keeler Co., E. 96
Kennicott Co. 97
Minneapolis Steel & Machinery Co. 109
Morrin Climax Boiler Co. . 96
Oil City Boiler Works. ... 96
Perkins Co., Jno. B. 70
Robb Engineering Co., Ltd. 91
Smith & Sons Co., Samuel. 95
Struthers-Wells Co. 105
Viter Mfg. Co. 106
Vogt Machine Co., Henry. . 96
Wickes Boiler Co. 96

Books
International Corr. Schools. 63
McGraw-Hill Book Co. 112

Brick, Fire
Harbison-Walker Refractories Co. 99
McLeod & Henry Co. 98

Calorimeters
American Steam Gauge & Valve Mfg. Co. 56, 57

Castings, Brass and Iron
Bruce-Macbeth Eng. Co. ... 104
Builders Iron Foundry. ... 97
Griffith & Wedge Co. 108
Homestead Valve Mfg. Co. 70
Hooven, Owens, Rentschler Co. 109
McClave-Brooks Co. 12
Neemes Bros. 90
Treadwell & Co., Inc., M. H. 90

Castings, Steel
Hooven, Owens, Rentschler Co. 109
Treadwell & Co., Inc., M. H. 90

Cement, Heat Resisting
Harbison-Walker Refractories Co. 99

Cement, Iron
Johns-Manville Co., H. W. 67
Smooth-On Mfg. Co. 6

Cement, Rubber
Peerless Rubber Mfg. Co. . 8

Chimneys, Brick
Kellogg Co., M. W. 72

Chimneys, Steel
Keeler Co., E. 96

Clocks
American Steam Gauge & Valve Mfg. Co. 56, 57
Ashton Valve Co., The. ... 68
Schaeffer & Budenberg Mfg. Co. 66

Clutches, Friction
Allis-Chalmers Co. 108

Coal
Consolidation Coal Co. 13

Coal and Ash Handling Machinery
Jeffrey Mfg. Co. 64, 75
Parson Mfg. Co. 91

Cocks, Blowoff
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86

Cocks, Gage
American Steam Gauge & Valve Mfg. Co. 56, 57
Chaplin-Fulton Mfg. Co. .. 97
Huyette Co., Inc., Paul B. . 66
Jenkins Bros. 61
Lunkenheimer Co., The. ... 4
Ohio Blower Co. 88
Ohio Brass Co. 97
Penberthy Injector Co. 11
Reliance Gauge Column Co. 98
"S-C" Regulator Co. 95
Schaeffer & Budenberg Mfg. Co. 66
Wright Mfg. Co. 74

Cocks, Steam
Dart Mfg. Co., E. M. 72
Lunkenheimer Co. 4
National Tube Co. ... 71, 72, 73
Robertson & Sons, Jas. L. . 65
Schutte & Koerting Co. ... 110
Sherwood Mfg. Co. 81

Combustion Chamber, Back Arch
Harbison-Walker Refractories Co. 99
McLeod & Henry Co. 98

Combustion Recorders
Precision Instrument Co. ... 66
Uehling Instrument Co. 96

Compound, Commutator
Dixon Crucible Co., Jos. ... 79

Condensers
Allis-Chalmers Co. 108
Anderson Co., V. D. 76
Baragwanath & Son, Wm. . 84
Cameron Steam Pump Works, A. S. 93
Connersville Blower Co., The 92
Epping-Carpenter Co. 92
Griscom-Spencer Co. 87
Kellogg Co., M. W. 72
McGowan Co., John H. 93

Condensers—Continued.
Minneapolis Steel & Machinery Co. 109
Schutte & Koerting Co. ... 110
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H. ... 93

Controllers, Feed Water
Chaplin-Fulton Mfg. Co. ... 97
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co. ... 3d cover
Mason Regulator Co. 68
Northern Equipment Co. ... 94
Squires Co., C. E. 75

Conveying Machinery
Jeffrey Mfg. Co. 64, 75

Cooling Plants
Power Specialty Co. 80
Schutte & Koerting Co. ... 110

Cooling Towers
Baragwanath & Son, Wm. . 84
Wheeler Cond. & Engr. Co. 92

Correspondence Schools
International Corr. Schools. 63

Couplings, Flexible Shaft
Bruce-Macbeth Engine Co. 104
Hooven, Owens, Rentschler Co. 109

Couplings, Pipe
Lagonda Mfg. Co. ... 3d cover
Liberty Mfg. Co. 7

Covering, Pipe and Boiler
Armstrong Cork Co. 72
Johns-Manville Co., H. W. 67

Cranes
Yale & Towne Mfg. Co. 91

Crank Pin Oiler
Richardson-Phenix Co. 78

Curbs, Manhole
Armstrong Mfg. Co. 66

Cylinder Boring Bars
Rooksby & Co., E. J. 110
Underwood & Co., H. B. ... 106

Cylinders, Rebored
Rooksby & Co., E. J. 110
Underwood & Co., H. B. ... 106

Die Stocks
Armstrong Mfg. Co. 66
Bignall & Keeler Mfg. Co. . 73
Curtis & Curtis Co. 71
Oster Mfg. Co. 85
Toledo Pipe Threading Machine Co. 73

Draft, Mechanical
Buffalo Steam Pump Co. ... 93
Parson Mfg. Co. 91
Schutte & Koerting Co. ... 110
Sturtevant Co., B. F. 103
Turbo-Blower Co. 64
Wing Mfg. Co., L. J. 64

Drills, Upright
Barnes Co., W. F. & John. . 88

Dust Collectors
Ohio Blower Co. 88
Schutte & Koerting Co. ... 110
Sturtevant Co., B. F. 103

Dynamos
Allis-Chalmers Co.....108
American Engine Co.....109
Bruce-Macbeth Eng. Co...104
Fort Wayne Electric Wks.113
Ridgway Dynamo & Engine Co.....109
Sturtevant Co., B. F.....103
Terry Steam Turbine Co... 66

Economizers, Fuel
Parson Mfg. Co..... 91
Sturtevant Co., B. F.....103
Westinghouse Machine Co.114

Ejectors
American Injector Co..... 92
Beggs & Co., James..... 82
Lunkenheimer Co..... 4
Ohio Injector Co..... 68
Penberthy Injector Co.... 11
Schaeffer & Budenberg Mfg. Co. 66
Schutte & Koerting Co....110

Electric Current
New York Edison Co..... 82

Engine Repairs
Rooksby & Co., E. J.....110
Underwood & Co., H. B...106

Engine Stops
Locke Regulator Co.....110
Schutte & Koerting Co...110

Engines, Combustion
Allis-Chalmers Co.....108
Beggs & Co., James..... 82
Bogart Gas Power Engineering Co.....104
Bruce-Macbeth Eng. Co...104
Buckeye Engine Co.....108
Columbus Machine Co.....104
International Harvester Co. of America.....105
Mietz Iron Fdry. & Mach. Works 104
Minneapolis Steel & Mchry. Co. 109
Otto Gas Engine Works...105
Struthers-Wells Co.....105
Turner-Fricke Mfg. Co....104
Westinghouse Machine Co.114
Wisconsin Engine Co.....102

Engines, Oil
Mietz Iron Foundry & Machine Works.....104

Engines, Pumping
Hooven, Owens, Rentschler Co. 109
McGowan Co., John H..... 93

Engines, Steam
Allis-Chalmers Co.....103
American Engine Co.....109
Ames Iron Works.....106
Ball Engine Co.....106
Beggs & Co., James..... 82
Buckeye Engine Co.....108
Buffalo Steam Pump Co... 93
Cooper Co., C. & G.....105
Fitchburg Steam Engine Co. 106
Griffith & Wedge Co.....108
Griscom-Spencer Co..... 87
Harris Steam Engine Co., Wm. A.....108
Harrisburg Foundry & Machine Works.....108
Hewes & Phillips Iron Wks.109
Hooven, Owens, Rentschler Co. 109
McIntosh, Seymour & Co..109
Minneapolis Steel & Machinery Co.....109
Perkins Co., Jno. B..... 70
Providence Engr. Works..105
Ridgway Dynamo & Engine Co.....109
Rollins Engine Co.....107
Skinner Engine Co.....106
Sturtevant Co., B. F.....103
Vilter Mfg. Co.....106
Watts-Campbell Co.....108
Westinghouse Machine Co.114
Wisconsin Engine Co.....102

Exhaust Heads
Burt Mfg. Co..... 16
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Hoppes Mfg. Co..... 88
Ohio Blower Co..... 88
Patterson & Co., Frank L.. 86
Robertson & Sons, Jas. L.. 65
Sturtevant Co., B. F.....103
Watson & McDaniel..... 93
Whitlock Coil Pipe Co.... 71
Wright Mfg. Co..... 74

Expansion Joints
Greene, Tweed & Co., 80, 4th cover
National Tube Co...71, 72, 73

Fans, Electric
Fort Wayne Electric Wks.113
Sturtevant Co., B. F.....103
Wing Mfg. Co., L. J..... 64

Fans, Exhaust and Ventilating
Anderson Co., V. D..... 76
Buffalo Steam Pump Co.. 93
Power Specialty Co..... 80
Schutte & Koerting Co....110
Sturtevant Co., B. F.....103
Turbo-Blower Co..... 64
Wing Mfg. Co., L. J..... 64

Feed Water Weighers
Kennicott Co. 97

Feeders, Boiler Compound
Richardson-Phenix Co. ... 78

Feeders, Furnace
Ohio Blower Co..... 88

Files and Rasps
Nicholson File Co.....100

Filters, Oil
Burt Mfg. Co..... 16
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Franklin Oil Filter Co..... 80
Liberty Mfg. Co..... 7
Nugent & Co., Wm. W..... 80
Richardson-Phenix Co. ... 78
Robertson & Sons, Jas. L.. 65
Wright Mfg. Co..... 74

Filters, Water
Beggs & Co., James..... 82
Griscom-Spencer Co..... 87
Scaife & Sons Co., Wm. B. 98

Fire Clay
Harbison-Walker Refractories Co. 99
McLeod & Henry Co..... 98

Firebox Blocks
Harbison-Walker Refractories Co. 99
McLeod & Henry Co. 98

Fittings, Ammonia
American Steam Gauge & Valve Mfg. Co.....56, 57
Greene, Tweed & Co., 80, 4th cover

Fittings, Steel
Nelson Valve Co..... 69

Flanges
Dart Mfg. Co., E. M..... 72
Jefferson Union Co..... 83
National Tube Co...71, 72, 73

Floats
Anderson Co., V. D..... 76
Naugatuck Mfg. Co..... 88
Reliance Gage Column Co. 98

Flue Gas Analysis Instruments
Pierce Co., Wm. B.. 2d cover
Precision Instrument Co.. 66

Forgings, Drop
Williams & Co., J. H.....101

Furnace Door Arch
Harbison-Walker Refractories Co. 99
McLeod & Henry Co..... 98

Furnace Linings
Harbison-Walker Refractories Co. 99

Furnaces, Smokeless
McClave-Brooks Co. 12
Murphy Iron Works..... 91

Gage Boards
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The..... 68

Gage Glasses
American Steam Gauge & Valve Mfg. Co.....56, 57
Chesterton Co., A. W..... 79
Garlock Packing Co..... 9
Peerless Rubber Mfg. Co.. 8
Penberthy Injector Co..... 11
Rogers Co., H. A..... 88
Schaeffer & Budenberg Mfg. Co. 66
Von Kokeritz & Co., R. G. 85

Gage Testing Outfit
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Schaeffer & Budenberg Mfg. Co. 66

Gages, Draft
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Bristol Co. .....4th cover
Precision Instrument Co.. 66
Schaeffer & Budenberg Mfg. Co. 66

Gages, Pressure
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Crosby Steam Gage & Valve Co. 67
Keeler Co., E. 96
Schaeffer & Budenberg Mfg. Co. 66

Gages, Recording
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The..... 68
Bristol Co. .....4th cover
Ohio Injector Co..... 68
Precision Instrument Co... 66
Schaeffer & Budenberg Mfg. Co. 66
Uehling Instrument Co.... 96

Gages, Vacuum
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The..... 68
Greene, Tweed & Co., 80, 4th cover
Precision Instrument Co... 66
Schaeffer & Budenberg Mfg. Co. 66
Schutte & Koerting Co....110

Gages, Water
American Steam Gauge & Valve Mfg. Co.....56, 57
Crosby Steam Gauge and Valve Co. 67
Greene, Tweed & Co., 80, 4th cover
Huyette Co., Inc., Paul B.. 66
Jenkins Bros. 61
Lunkenheimer Co. 4
Ohio Blower Co..... 88
Ohio Brass Co..... 97
Penberthy Injector Co..... 11
Reliance Gauge Column Co. 98
Schaeffer & Budenberg Mfg. Co. 66
Wright Mfg. Co..... 74

Gas, Exhausters
Ohio Blower Co..... 88
Parson Mfg. Co..... 91

Gas Producers
Bogart Gas Power Engineering Co. 104
Griscom-Spencer Co. 87
Minneapolis Steel & Mchy. Co. 109
Wisconsin Engine Co.....102

Gaskets
Chesterton Co., A. W..... 79
Diamond Rubber Co..... 94
Eureka Packing Co.....65, 76
Garlock Packing Co..... 9
Greene, Tweed & Co., 80, 4th cover
Jenkins Bros. 61
Johns-Manville Co., H. W.. 67
Keeler Co., E. 96
New York Belting & Packing Co., Ltd. 10
Peerless Rubber Mfg. Co.. 8
Smooth-On Mfg. Co..... 6

Gears
New Process Raw Hide Co.111

Generating Sets
American Engine Co.....109
Fort Wayne Electric Wks.113
Harris Steam Engine Co., Wm. A.....108
Harrisburg Foundry & Machine Works 108
Mietz Iron Fdry. & Mach. Works 104
Ridgway Dynamo & Engine Co. 109
Sturtevant Co., B. F.....103

Governors, Pump
Chaplin-Fulton Mfg. Co... 97
Davis Regulator Co., G. M., 4th cover
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Hughson Steam Specialty Co. 68
Locke Regulator Co.... 70,110
Mason Regulator Co..... 68
Northern Equipment Co... 94
Schade Valve Mfg. Co..... 70
"S-C" Regulator Co..... 95
Squires Co., C. E..... 75
Watson & McDaniel Co.... 93

Governors, Pump Speed
Mason Regulator Co..... 68

Graphite
Dixon Crucible Co., Jos.... 79
Garlock Packing Co..... 9
Greene, Tweed & Co 80, 4th cover

Grates
Armsrong Mfg. Co..... 90
Babcock & Wilcox Co..... 95
Beggs & Co., James..... 82
Casey-Hedges Co. 95
Long Grate Bar Co..... 90
Martin Grate Co..... 90
McClave-Brooks Co. 12
Neemes Bros. 90
Perfection Grate Co..... 90
Robertson & Sons, Jas. L.. 65
Salamander Grate Bar Co. 90
Treadwell & Co., Inc., M. H. 90
Washburn & Granger Co.. 90

Grease
Albany Lubricating Co.... 81
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos.... 79
Keystone Lubricating Co.. 3
N. Y. & N. J. Lubricant Co. 79
Walton Co., F. S.....14, 15

Grease Extractors
American Steam Gauge & Valve Mfg. Co.....56, 57
Beggs & Co., James..... 82
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Griscom-Spencer Co. 87

Heaters and Purifiers, Feed Water
Baragwanath & Son, Wm.. 84
Blake & Knowles Steam Pump Works..... 86
Casey-Hedges Co..... 95
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Graver Tank Works, Wm.. 98
Griscom-Spencer Co..... 87
Harrison Safety Boiler Works 59
Hoppes Mfg. Co..... 88
Minneapolis Steel & Machinery Co.....109
National Pipe Bending Co. 85
Open Coil Heater & Purifier Co. 74
Patterson & Co., Frank L.. 86
Robertson & Sons, Jas. L.. 65
Schutte & Koerting Co....110
Sturtevant Co., B. F.....103
Webster & Co., Warren.... 86
Wheeler Mfg. Co., C. H... 93
Whitlock Coil Pipe Co.... 71
Wickes Boiler Co..... 96

Heating and Ventilating Systems
Ohio Blower Co..... 88
Schutte & Koerting Co....110
Sturtevant Co., B. F.....103
Wing Mfg. Co., L. J..... 64

Heating, Central Station
American District Steam Co. 100

Hoists, Combustion Engine
Mietz Iron Fdry. & Mach. Works 104

Hoists, Electric
Allis-Chalmers Co.....108
Yale & Towne Mfg. Co..... 91

Hoists, Hand
Yale & Towne Mfg. Co.... 91

Hose, Metal
American Metal Hose Co..100
Liberty Mfg. Co..... 7
Pennsylvania Flexible Metallic Tubing Co.....100

Hose, Rubber
Diamond Rubber Co..... 94
Garlock Packing Co..... 9
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7
New York Belting & Packing Co..... 10
Peerless Rubber Mfg. Co. 8
Pennsylvania Flexible Metallic Tubing Co.....100

Ice and Refrigerating Machinery
Vilter Mfg. Co.....106
Vogt Machine Co., Henry.. 96
Watts-Campbell Co.....108

Ice Machine Repairs
Rooksby & Co., E. J.....110
Underwood & Co., H. B....106

Indicators, Ammonia
American Steam Gauge & Valve Mfg. Co.....56, 57

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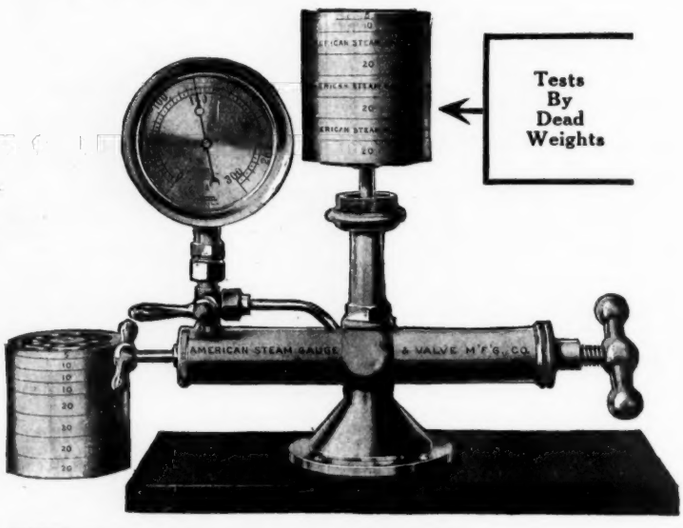

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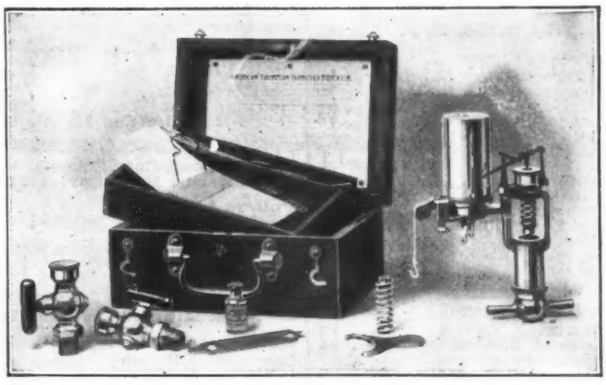

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American Steam Gauge & Valve Mfg. Co.....56, 57
Trill Indicator Co..... 71

Indicators, Flow
Richardson-Phenix Co..... 78

Indicators, Gas Engine
Trill Indicator Co..... 71

Indicators, Speed
American Steam Gauge & Valve Mfg. Co.....56. 57
Starrett Co., L. S..... 88

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co.....56, 57
Crosby Steam Gage & Valve Co..... 67
Robertson & Sons Jas. L.. 65
Trill Indicator Co..... 71

Injectors
American Injector Co..... 92
Detroit Lubricator Co..... 81
Jenkins Bros..... 61
Lunkenheimer Co..... 4
Ohio Injector Co..... 68
Penberthy Injector Co..... 11
Robertson & Sons, Jas. L.. 65
Schaeffer & Budenberg Mfg. Co. 66
Schutte & Koerting Co....110
Sherwood Mfg. Co..... 81

Lamps, Electric
Johns-Manville Co., H. W. 67

Lathes, Foot Power
Barnes Co., W. F. & John. 88

Lubricators, Cylinder
Albany Lubricating Co.... 81
Detroit Lubricator Co..... 81
Greene, Tweed & Co., 80, 4th cover
Griscom-Spencer Co. 87
Keystone Lubricating Co.. 3
Lunkenheimer Co..... 4
Manzel Bros. Co..... 81
Ohio Injector Co..... 68
Penberthy Injector Co..... 11
Richardson-Phenix Co..... 78
Robertson & Sons. Jas. L.. 65
Sherwood Mfg. Co..... 81
Webster & Co., Warren... 86

Lubricators, Force Feed
Greene, Tweed & Co., 80, 4th cover
Lunkenheimer Co..... 4
Ohio Injector Co..... 68
Richardson-Phenix Co..... 78
Sherwood Mfg. Co..... 81

Machinists, General
Bruce-Macbeth Eng. Co...104
Providence Engine Works.105

Mats and Matting
Diamond Rubber Co..... 94
New York Belting & Packing Co..... 10
Peerless Rubber Mfg. Co.. 8

Metal Bearing
Magnolia Metal Co.....110

Meters, Steam
St. John, G. C..... 93

Meters, Water
Builders Iron Foundry.. . 97
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Harrison Safety Boiler Works 59
St. John, G. C..... 93

Micrometers
Starrett Co., L. S..... 88

Milling Machines, Portable
Underwood & Co., H. B...106

Motors, Electric
Allis-Chalmers Co.....108
American Engine Co.....109
Fort Wayne Electric Wks.113
Ridgway Dynamo & Engine Co.....109
Sturtevant Co., B. F.....103

Motors, Water
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Oil and Grease Cups
Albany Lubricating Co.... 81
American Injector Co..... 92
Detroit Lubricator Co..... 81
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Griscom-Spencer Co..... 87
Keystone Lubricating Co.. 3
Liberty Mfg. Co..... 7

Oil and Grease Cups—Cont.
Lunkenheimer Co..... 4
New York & New Jersey Lubricant Co..... 79
Ohio Injector Co..... 68
Penberthy Injector Co.... 11
Richardson-Phenix Co..... 78
Schaeffer & Budenberg Mfg. Co. 66
Sherwood Mfg. Co..... 81

Oil Burners
Hammel Oil Burner Co.... 91
Lunkenheimer Co..... 4
Parson Mfg. Co..... 91

Oil Reservoirs
Bowser & Co., Inc., S. F... 79
Burt Mfg. Co..... 16
Graver Tank Works, Wm.. 98
Richardson-Phenix Co.... 78

Oil Tanks
Bowser & Co., Inc., S. F... 79
Richardson-Phenix Co..... 78

Oilers, Telescopic
Nugent & Co., Wm. W..... 80
Penberthy Injector Co.... 11

Oiling Devices
Lunkenheimer Co..... 4
Nugent & Co., Wm. W.... 80
Penberthy Injector Co.... 11
Sherwood Mfg. Co..... 81

Oiling Systems
Albany Lubricating Co.... 81
Bowser & Co., Inc., S. F... 79
Burt Mfg. Co..... 16
Detroit Lubricator Co..... 81
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lunkenheimer Co..... 4
Nugent & Co., Wm. W.... 80
Richardson-Phenix Co..... 78

Oils
Albany Lubricating Co.... 81
Dearborn Drug & Chemical Works 5
New York & New Jersey Lubricant Co..... 79
Walton Co., F. S.....14, 15

Packing, Cylinder
Rooksby & Co., E. J.....110

Packing, Flange
Bowers Rubber Works.... 94
Chesterton Co., A. W..... 79
Diamond Rubber Co..... 94
Eureka Packing Co.....65, 76
Garlock Packing Co..... 9
Greene, Tweed & Co., 80, 4th cover
Jenkins Bros..... 61
Johns-Manville Co., H. W. 67
Keeler Co., E..... 96
New York Belting & Packing Co..... 10
Peerless Rubber Mfg. Co.. 8
Smooth-On Mfg. Co..... 6
Von Kokeritz & Co., R. G.. 85

Packing, Hydraulic
Chesterton Co., A. W..... 79
Diamond Rubber Co..... 94
Eureka Packing Co.....65, 76
Garlock Packing Co..... 9
Johns-Manville Co., H. W. 67
Steel Mill Packing Co..... 94
Schieren Co., Chas. A..... 88
Von Kokeritz & Co., R. G.. 85

Packing, Pump Valve
Diamond Rubber Co..... 96
Von Kokeritz & Co., R. G.. 85

Packing, Rod
Bowers Rubber Works.... 79
Chesterton Co., A. W..... 79
Diamond Rubber Co..... 94
Eureka Packing Co.....65, 76
Garlock Packing Co..... 9
Greene, Tweed & Co., 80, 4th cover
Johns-Manville Co., H. W.. 67
New York Belting & Packing Co..... 10
Peerless Rubber Mfg. Co.. 8
Power Specialty Co..... 80
Steel Mill Packing Co..... 94
Tripp Metallic Packing Co. 94
Von Kokeritz & Co., R. G.. 85

Packing, Valve Stem
Diamond Rubber Co..... 94
Eureka Packing Co.....65, 76
Garlock Packing Co..... 9
Greene, Tweed & Co., 80, 4th cover
Tripp Metallic Packing Co. 94

Pipe
Harrisburg Mfg. & Boiler Co. 97
Kellogg & Co., M. W..... 72
National Tube Co...71, 72, 73

Pipe Bending
Kellogg Co., M. W..... 72
National Pipe Bending Co. 85
Whitlock Coil Pipe Co.... 71

Pipe Clamp
Yarnall-Waring Co..... 73

Pipe Coils
National Pipe Bending Co. 85
National Tube Co...71, 72, 73
Whitlock Coil Pipe Co..... 71

Pipe Cutting and Threading Machines
Armstrong Mfg. Co..... 66
Bignall & Keeler Mfg. Co.. 73
Curtis & Curtis Co..... 71
Oster Mfg. Co..... 85
Toledo Pipe Threading Machine Co..... 73
Treadwell Co., Inc., M. H.. 90
Trimont Mfg. Co.....102
Williams & Co., J. H.....101

Pipe, Fittings
Jefferson Union Co..... 83
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73
Pittsburg Valve Foundry & Construction Co..... 70
Trimont Mfg. Co.....102

Pipe Riveted Steel
Graver Tank Works, Wm. 98
Harrisburg Mfg. & Boiler Co. 97

Pipe, Welded and Seamless
National Tube Co...71, 72, 73

Piping, Blower
Ohio Blower Co..... 88

Piping, High Pressure
Kelogg Co., M. W..... 72
Whitlock Coil Pipe Co.... 71

Planimeters
American Steam Gauge & Valve Mfg. Co.....56, 57
Robertson & Sons Jas. L.. 65
Schaeffer & Budenberg Mfg. Co. 66
Trill Indicator Co..... 71

Plumbago
Dixon Crucible Co., Jos.... 79

Polish, Metal
Chesterton Co., A W..... 79
Hoffman Geo. W.....105
Johns-Manville Co., H. W. 67

Publishers
International Corr. Schools. 63
McGraw-Hill Book Co.....112

Pulleys
Greene, Tweed & Co., 80, 4th cover
Minneapolis Steel & Machinery Co.....109

Pump, Valve Rotor
Cooley & Milligan..... 72

Pumps, Air
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
McGowan Co., John H..... 93
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H.... 93

Pumps, Centrifugal
Allis-Chalmers Co.....108
Deming Co..... 93
Quimby, Inc., Wm. E..... 92
Terry Steam Turbine Co... 66
Worthington, Henry R., 1st cover

Pumps, Deep Well
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
McGowan Co., John H..... 93

Pumps, Electric
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
Quimby, Inc., Wm E..... 92

Pumps, Jet
McGowan Co., John H..... 93

Pumps, Oil
Burt Mfg. Co..... 16
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
Lunkenheimer Co..... 4
Manzel Bros. Co..... 81
Patterson & Co., Frank L.. 86
Quimby, Inc., Wm E..... 92
Richardson-Phenix Co..... 78
Sherwood Mfg. Co..... 81

Pumps, Oil Force Feed
Detroit Lubricator Co.... 81
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 78

Pumps, Power
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
Quimby, Inc., Wm. E..... 92
Patterson & Co., Frank L.. 86
Perkins Co., Jno. B..... 70
Wheeler Mfg. Co., C. H... 93
Whitlock Coil Pipe Co.... 71

Pumps, Screw
Quimby, Inc., Wm. E..... 92

Pumps, Steam
Allis-Chalmers Co.....108
Cameron Steam Pump Works, A. S..... 93
Deming Co..... 93
Epping-Carpenter Co..... 92
Mason Regulator Co..... 68
McGowan Co., John H..... 93
Minneapolis Steel & Machinery Co.....109
Perkins Co., Jno. B..... 70
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H... 93
Worthington, Henry R., 1st cover

Pumps, Vacuum
Cameron Steam Pump Works, A. S..... 93
Connersville Blower Co., The 92
McGowan Co., John H..... 93
Wheeler Cond. & Engr. Co. 92
Wheeler Mfg. Co., C. H.... 93

Pyrometers
American Steam Gauge & Valve Mfg. Co.....56, 57
Schaeffer & Budenberg Mfg. Co. 66

Rams, Steam
Penberthy Injector Co.... 11

Reducing Wheels
American Steam Gauge & Valve Mfg. Co.....56, 57
Robertson & Sons, Jas. L.. 65
Trill Indicator Co..... 71

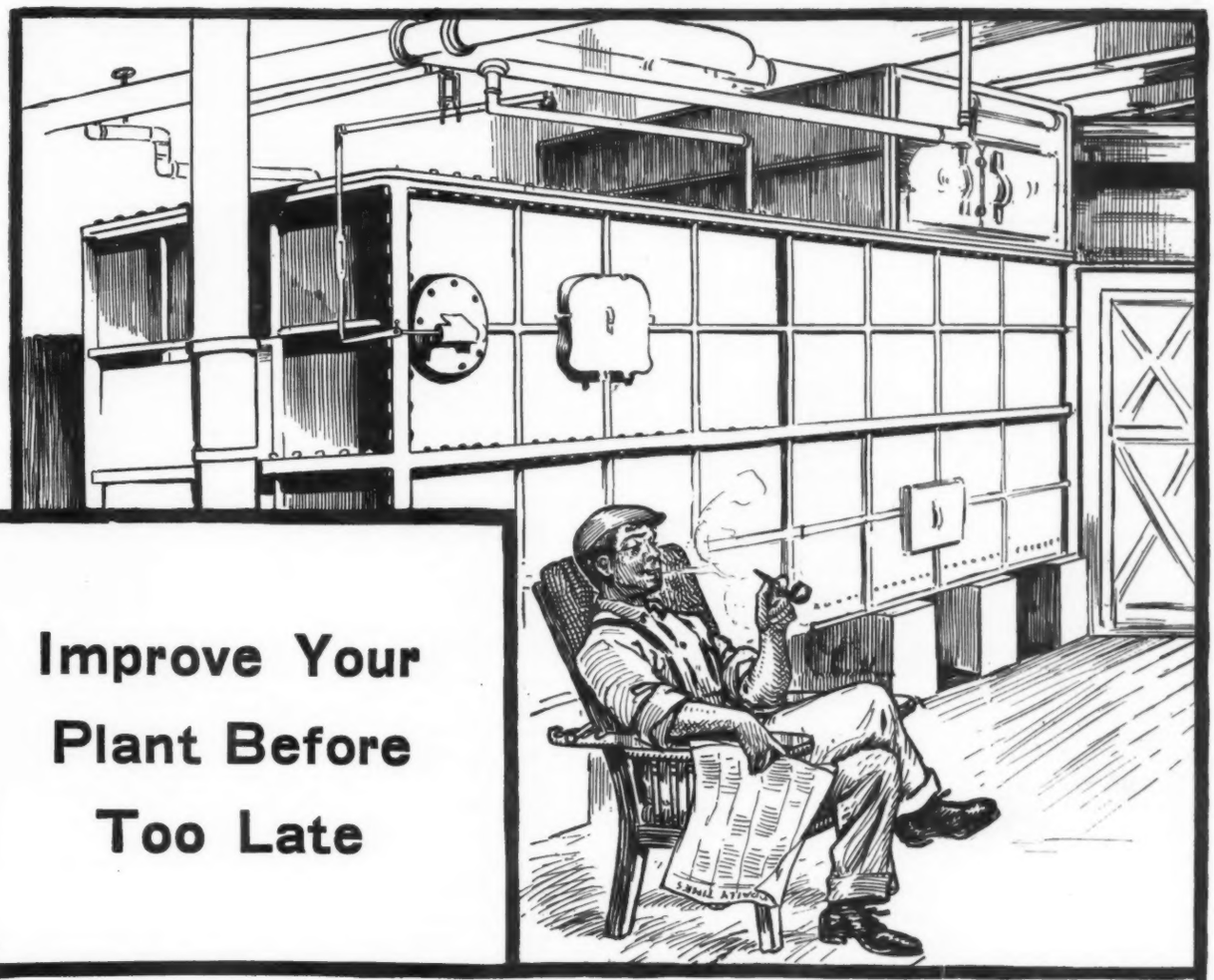
Regulators, Damper
Davis Regulator Co., G. M., 4th cover
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co....3d cover
Locke Regulator Co....70, 110
Mason Regulator Co..... 68
Robertson & Sons, Jas. L.. 65
"S-C" Regulator Co..... 95
Schaeffer & Budenberg Mfg. Co. 66
Turbo-Blower Co..... 64

Regulators, Feed Water
American District Steam Co. 100
Davis Regulator Co., G. M., 4th cover
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Harrison Safety Boiler Works 59
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7
Mason Regulator Co..... 68
Northern Equipment Co... 94
"S-C" Regulator Co..... 95
Squires Co., C. E..... 75

Regulators, Pressure
American District Steam Co. 100
Chaplin-Fulton Mfg. Co... 97
Davis Regulator Co., G. M., 4th cover
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Hughson Steam Specialty Co. 68
Lagonda Mfg. Co....3d cover
Lytton Mfg. Corporation.. 74
Mason Regulator Co..... 68
Northern Equipment Co... 94
Ohio Brass Co..... 97
Robertson & Sons, Jas. L.. 65
Squires Co., C. E..... 75
Watson & McDaniel Co.... 93

Regulators, Pump
Elliott Co., 7, 68, 70, 76, 79, 80, 85, 86
Hughson Steam Specialty Co. 68
Mason Regulator Co..... 68
"S-C" Regulator Co..... 95
Squires Co., C. E..... 75

Regulators, Tank
American Radiator Co..... 85



Improve Your Plant Before Too Late

In a recent issue of *POWER* appeared a true tale of how an engineer came to lose his job.

It was an old plant, somewhat run down at the heels, the engine exhausting plenty of steam to atmosphere, and although equipped with an old-fashioned closed heater, the boilers were fed with comparatively cold water. The engine received steam through a long exposed pipe, with no steam separator.

Well, one day along comes the central station solicitor, and by a little clever, quick figuring convinces the manager that he can save money by purchasing electric power, and shutting down the engine.

RESULT: Another engineer out of a job.

Now, this plant requires steam for heating. How could the central station man compete in the production of power with a steam engine used as a reducing valve between the boiler and the heating system? Practically as much coal is needed, you know, to make a pound of water into steam for heating as to make a pound of high pressure steam which can be used first in the engine, then in a **Cochrane Feed Water Heater** for heating the boiler feed up to 210° F. or higher, and finally in an exhaust steam heating system in every respect as good and satisfactory as a live steam heating system.

Suppose the engineer had been properly fore-handed and had put in a **Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver,** to purify the exhaust steam of oil before it was used in the heating system, so that the condensed returns might be brought back to the heater and heated up to a full 210° F. or higher before feeding into the boiler, and if further the engine had been protected by a **Cochrane Receiver Separator,** would there have been any question about the manager being satisfied with things as they were?

And we had almost overlooked another point! Due to the long steam pipe, there was some 25 lbs. drop in pressure between the boiler and the engine. A **Cochrane Receiver Separator** would have helped that, since it would have served to store steam between the periods of admission to the engine cylinder, and would have enabled the long, crooked pipe line to maintain nearly boiler pressure in the valve chest. Moreover, using dry steam, only half as much cylinder oil would have been needed.

We are always pleased to assist engineers in figuring on ways and means of improving plant economy. We furnish data, sketches for lay-outs, and information which enable them to put the case before the boss in the right light.

Send for our book on **"The Utilization of Exhaust Steam,"** or our **"Exhaust Steam Heating Encyclopedia,"** and study the means by which the economy of your plant can be improved.

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Revolution Counters
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Schuchardt & Schütte..... 75
Starrett Co., L. S..... 88

Rope, Transmission
American Mfg. Co..... 89
Columbian Rope Co..... 66

Rubber Joints
Diamond Rubber Co..... 94

Second Hand Machinery
Hewes & Phillips Iron Wks.109
National Meter Co..... 64
Stewart Co., The Paul..... 64

Separators, Ammonia
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Harrison Safety Boiler Works 59

Separators, Oil
Austin Separator Co..... 74
Baragwanath & Son, Wm.. 84
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Harrison Safety Boiler Works 59
Hoppes Mfg. Co..... 88
Liberty Mfg. Co..... 7
Nashua Machine Co..... 75
Ohio Blower Co..... 88
Robertson & Sons. Jas. L.. 65
Wright Mfg. Co..... 74

Separators, Steam
Austin Separator Co..... 74
Baragwanath & Son, Wm.. 84
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Griscom-Spencer Co..... 87
Harrison Safety Boiler Works 59
Hoppes Mfg. Co..... 88
Hughson Steam Specialty Co. 68
Keeler Co., E..... 96
Liberty Mfg. Co..... 7
Nashua Machine Co..... 75
Ohio Blower Co..... 88
Patterson & Co., Frank L.. 86
Robertson & Sons, Jas. L.. 65
Watson & McDaniel..... 93
Whitlock Coil Pipe Co..... 71
Wright Mfg. Co..... 74

Sight Feeds
Richardson-Phenix Co..... 78

Skylights
Burt Mfg. Co..... 16

Smoke Recorders
Hamler-Eddy Smoke Recorder Co..... 96

Spray Nozzles
Buffalo Steam Pump Co.... 93
Schutte & Koerting Co....110

Stokers, Chain Grate
Babcock & Wilcox Co..... 95

Stokers, Mechanical
American Ship Windlass Co. 91
Babcock & Wilcox Co..... 95
Lagonda Mfg. Co....3d cover
McClave-Brooks Co..... 12
Murphy Iron Works..... 91
Parson Mfg. Co..... 91
Under-Feed Stoker Co. of America 89
Westinghouse Machine Co.114

Strainers, Pump Suction
American Ship Windlass Co. 91
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co....3d cover

Strainers, Water
American Injector Co..... 92
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Stuffing Boxes
Short Flexible Stuffing Box Co. 74

Superheaters
Babcock & Wilcox Co..... 95
Lagonda Mfg. Co....3d cover
Nelson Valve Co..... 69
Power Specialty Co..... 80
Providence Engr. Works..105
Whitlock Coil Pipe Co.... 71

Tachometers
Schaeffer & Budenberg Mfg. Co. 66
Schuchardt & Schütte..... 75

Tanks
Graver Tank Works, Wm.. 98
Griscom-Spencer Co..... 87
Keeler Co., E..... 96
Morrin Climax Boiler Co.. 96
Wright Mfg. Co..... 74

Taps, Stocks and Dies
Armstrong Mfg. Co..... 66
Bignall & Keeler Mfg. Co.. 73
Curtis & Curtis Co..... 71
Oster Mfg. Co..... 85
Toledo Pipe Threading Machine Co..... 73

Thermometers
American Steam Gauge & Valve Mfg. Co.....56, 57
Bristol Co. .....4th cover
Schaeffer & Budenberg Mfg. Co. 66

Tools, Portable Repair
Rooksby & Co., E. J.....110
Underwood & Co., H. B....106

Transformers and Converters
American Steam Gauge & Valve Mfg. Co.....56, 57
Jeffrey Mfg. Co.....64, 75

Transmission, Power
American Mfg. Co..... 89
Columbian Rope Co..... 66

Traps, Return
Lytton Mfg. Corporation.. 74
Nashua Machine Co..... 75

Traps, Steam
American District Steam Co. 100
Anderson Co., V. D..... 76
Chaplin-Fulton Mfg. Co... 97
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Griscom-Spencer Co..... 87
Harrison Safety Boiler Works 59
Jenkins Bros..... 61
Lytton Mfg. Corporation.. 74
Morehead Mfg. Co..... 76
Nashua Machine Co..... 75
Newhall Engr. Co., Geo. M. 77
Ohio Blower Co..... 88
Open Coil Heater & Purifier Co..... 74
Reliance Gauge Column Co. 98
Rogers Co., H. A..... 88
Schutte & Koerting Co....110
Squires Co., C. E..... 75
Watson & McDaniel Co.... 93
Wright Mfg. Co..... 74

Traps, Vacuum
Griscom-Spencer Co..... 87
Lytton Mfg. Corporation.. 74
Morehead Mfg. Co..... 76
Nashua Machine Co..... 75
Open Coil Heater & Purifier Co..... 74
Schutte & Koerting Co....110

Tube Cap Reseating Machines
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Tube Cutters
Armstrong Mfg. Co..... 66
Lagonda Mfg. Co....3d cover
Liberty Mfg. Co..... 7

Tube Expanders
Liberty Mfg. Co..... 7

Tube Protectors
Liberty Mfg. Co..... 7

Tubing
Johns-Manville Co., H. W. 67
National Tube Co...71, 72, 73
Penn-Flexible Metallic Tubing Co.....100

Turbines, Centrifugal
Terry Steam Turbine Co... 66

Turbines, Hydraulic
Allis-Chalmers Co.....108

Turbines, Steam
Allis-Chalmers Co.....108
Davis Regulator Co., G. M., 4th cover
Hooven, Owens, Rentschler Co. 109
Kerr Turbine Co.....101
Sturtevant Co., B F.....103
Terry Steam Turbine Co... 66
Westinghouse Machine Co. 114
Wing Mfg. Co., L. J..... 64

Unions
Dart Mfg. Co., E. M..... 72
Jefferson Union Co..... 83
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73
Ohio Brass Co..... 97

Valve Balls
Diamond Rubber Co..... 94

Valve Disks
Diamond Rubber Co..... 94

Valve Washers, Leather
Schieren Co., Chas. A..... 88

Valves, Ammonia
Chapman Valve Mfg. Co... 70
Monarch Valve & Mfg. Co. 68

Valves, Angle
Homestead Valve Mfg. Co. 70
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co. 68
National Tube Co...71, 72, 73
Nelson Valve Co..... 69
New Bedford Valve Mfg. Co. 70

Valves, Automatic Cutoff
Lagonda Mfg. Co....3d cover

Valves, Back Pressure
Harrison Safety Boiler Works 59
Hughson Steam Specialty Co. 68
Jenkins Bros..... 61
McGowan Co., John H..... 93
Perkins Co., Jno. B..... 70
Schutte & Koertirg Co....110

Valves, Blowoff
Ashton Valve Co., The.... 68
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Homestead Valve Mfg. Co. 70
Jenkins Bros..... 61
Liberty Mfg. Co..... 7
Lunkenheimer Co..... 4
Lytton Mfg. Corporation.. 74
Nelson Valve Co..... 59
Yarnall-Waring Co..... 73

Valves, Bypass
Mason Regulator Co..... 68
Monarch Valve & Mfg. Co. 68
Nelson Valve Co..... 69

Valves, Check
Greene, Tweed & Co., 80, 4th cover
Jenkins Bros..... 61
Kennedy Valve Mfg. Co... 67
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co.. 68
National Tube Co...71, 72, 73
Nelson Valve Co..... 69
Northern Equipment Co... 94

Valves, Cylinder Relief
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Lunkenheimer Co..... 4
Perkins Co., Jno. B..... 70

Valves, Exhaust Relief
Jenkins Bros..... 61
Nelson Valve Co..... 69

Valves, Float
Homestead Valve Mfg. Co. 70
Schade Valve Mfg Co..... 70

Valves, Free Exhaust
Davis Regulator Co., G. M., 4th cover
Schutte & Koerting Co....110

Valves, Gate
Chapman Valve Mfg. Co.. 70
Detroit Lubricator Co..... 81
Greene, Tweed & Co., 80, 4th cover
Jenkins Bros..... 61
Kennedy Valve Mfg. Co... 67
Lunkenheimer Co..... 4
Monarch Valve & Mfg. Co. 68
National Tube Co...71, 72, 73
Nelson Valve Co..... 69
New Bedford Valve Mfg. Co. 70
Ohio Brass Co..... 97
Pittsburgh Valve, Foundry & Construction Co..... 70

Valves, Globe
Detroit Lubricator Co..... 81
Jenkins Bros..... 61
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73
Nelson Valve Co..... 69
New Bedford Valve Mfg. Co 70
Ohio Brass Co..... 97

Valves, Pump
Garlock Packing Co..... 9
Jenkins Bros..... 61
New York Belting & Packing Co..... 10
Peerless Rubber Mfg. Co.. 8
Schade Valve Mfg. Co..... 70

Valves, Reducing
Davis Regulator Co., G. M., 4th cover
Hughson Steam Specialty Co. 68

Valves, Reducing—Continued.
Locke Regulator Co....70, 110
Lytton Mfg. Corporation.. 74
Mason Regulator Co..... 68
Ohio Brass Co..... 97
Schade Valve Mfg. Co..... 70
Schutte & Koerting Co....110
Squires Co., C. E..... 75

Valves, Regrinding
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73
Nelson Valve Co..... 69

Valves, Regulating
Davis Regulator Co., G. M., 4th cover
Engineers Appliance Co., The 67
Hughson Steam Specialty Co. 68
Lunkenheimer Co..... 4
Lytton Mfg. Corporation.. 74
Mason Regulator Co..... 68
Nelson Valve Co..... 69
Ohio Brass Co..... 97
Schade Valve Mfg. Co..... 70
Squires & Co., C. E..... 75

Valves, Return Stop
Lagonda Mfg. Co....3d cover
Locke Regulator Co....70, 110

Valves, Safety
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The.... 68
Crosby Steam Gage & Valve Co. 67
Detroit Lubricator Co..... 81
Jenkins Bros..... 61
Lagonda Mfg. Co....3d cover
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73

Valves, Stop Check
Jenkins Bros..... 61
Lagonda Mfg. Co....3d cover
Perkins Co., Jno. B..... 70
Schutte & Koerting Co....110

Valves, Superheated Steam
Chapman Valve Mfg. Co... 70
Lunkenheimer Co..... 4
Nelson Valve Co..... 69
Schutte & Koerting Co....110

Valves, Tank
Engineers Appliance Co., The 67
Nelson Valve Co..... 69
Schade Valve Mfg. Co..... 70

Valves, Throttle
Detroit Lubricator Co..... 81

Valves, Trip Throttle
Schutte & Koerting Co....110

Ventilators
Burt Mfg. Co..... 16
Ohio Blower Co..... 88
Schutte & Koerting Co...110
Turbo-Blower Co..... 64
Wing Mfg. Co., L. J..... 64

Vises
Armstrong Mfg. Co..... 66
Curtis & Curtis Co..... 71
Williams & Co., J. H.....101

Water Columns
American Steam Gauge & Valve Mfg. Co.....56, 57
Elliott Co.,
7, 68, 70, 76, 79, 80, 85, 86
Huyette Co., P. B..... 66
Lunkenheimer Co..... 4
National Tube Co...71, 72, 73
Reliance Gauge Column Co. 98
Robertson & Sons, Jas. L.. 65
Wright Mfg Co..... 74

Water Softening Apparatus
Dearborn Drug & Chemical Works..... 5
Graver Tank Works, Wm.. 98
Harrison Safety Boiler Works 59
Scaife & Sons Co., Wm. B.. 98

Whistles
American Steam Gauge & Valve Mfg. Co.....56, 57
Ashton Valve Co., The..... 68
Crosby Steam Gauge & Valve Co..... 67
Lunkenheimer Co..... 4

Wrenches, Nut and Bolt
Trimont Mfg. Co.....102
Williams & Co., J. H.....101

Wrenches, Pipe
Armstrong Mfg. Co..... 66
Curtis & Curtis Co..... 71
Trimont Mfg. Co.....102
Williams & Co., J. H.....101

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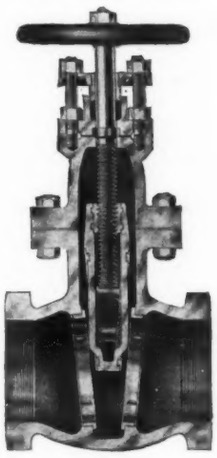

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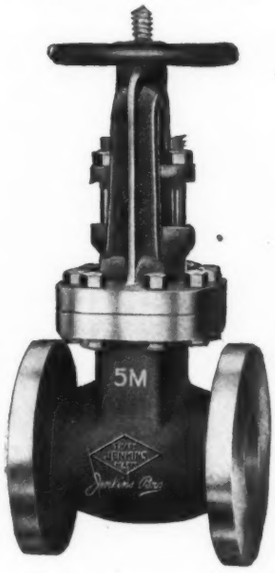

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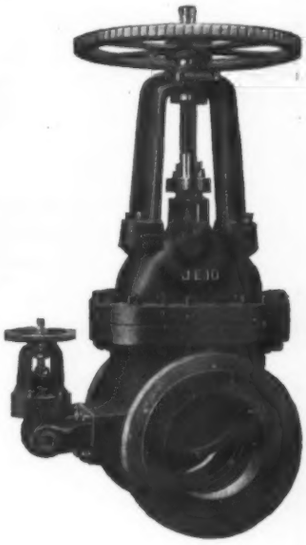

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Vol. 34. No. 26.

OUTLINE OF TOPICS

PAGE

NEW GENERATING STATION, PORTLAND, ORE. . . . . *Edward A. West* 942
An alternating- and direct-current plant built to supplement the existing steam and hydraulic plants of the Portland Ry., Light & Power Co.

MASSACHUSETTS LICENSE LAW REVISED 946
Changes have been made in the application for examination and in the appeal therefrom. The boiler-horsepower rating has been changed, a turbine rating appended and several changes of minor importance made.

NOTES ON GROUTING BEDPLATES . . . . . *F. C. Holly* 947
Cement, rust joint and sulphur grouting with directions for their application.

TOM HUNTER, HOISTING ENGINEER . . . . . *Warren O. Rogers* 948
The author has a talk with an ex-hoisting engineer who tells him some interesting things about hoisting engines.

EFFICIENCY OF RECIPROCATING ENGINES 950
A controversy between Prof. Stumpf and Mr. Heilman regarding the relative merits of the uniflow engine and the Wolf locomobile.

AN ANALYSIS OF SOME RECENT GAS ENGINE FAILURES . . . . *Howard S. Knowlton* . . . 954
The article is based on the findings of a well known British insurance inspector and sheds a great deal of light on the causes of failure.

THE BOGERT AUXILIARY HEATER 956
A horizontal tubular boiler utilizing waste heat of gas-engine exhaust and generating 2½ to 3 lb. of steam at 60 lb. pressure per brake horsepower-hour.

GAS POWER IN A MANUFACTURING ESTABLISHMENT 957

THE NONPRECIPITATION OF CALCIUM CHLORIDE FROM BRINE BY AMMONIA . . . . . *Morgan B. Smith* 958
In which it is shown that calcium chloride is not precipitated out of solution by ammonia, but magnesium chloride is, and from a mixed-chloride brine the magnesium is readily precipitated, whereas the calcium is not.

OPERATING AMMONIA COMPRESSORS BY AID OF THERMOMETERS . *E. N. Friedmann* 959
Thermometers should be used as they teach the engineer the relations existing between volumes and temperatures.

STEEL VERSUS IRON PIPE IN REFRIGERATING WORK . . . . . *P. DeC. Ball* 960
A brief comparison in which steel pipe with its uniform quality of material and absence of slag is favored.

EDITORIALS 961-962

PRACTICAL LETTERS 965-967

EXAMPLE OF POOR DESIGNING
PLUGGED BOILER HEAD
OIL GROOVES
HOW HE GOT A RAISE
NOISY VALVE GEAR TAPPETS
EXCELLENT STEAM CHARTS
CENTRIFUGAL PUMP REPAIR
HOME-MADE WATER HEATER
SIZE OF TANK REQUIRED

DISCUSSION LETTERS 968-971

POTBLYN, PUMP DOCTOR
SAND FOR HOT BOXES
AIR COMPRESSOR RUNNING UNDER
RUNNING CORLISS ENGINE WITH ONE STEAM VALVE
BURNING FUEL OIL
GRAFT
EFFECTIVE PRESSURE OF A SCREW
A TWENTY FOUR HOUR LOG
TROUBLE WITH LEAKING TUBES

INQUIRIES OF GENERAL INTEREST 972
NEWS 973
NEW PUBLICATIONS 974
MOMENTS WITH THE AD. EDITOR 51
BUSINESS ITEMS 52
ADVERTISING INDEX 53

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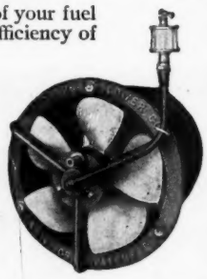

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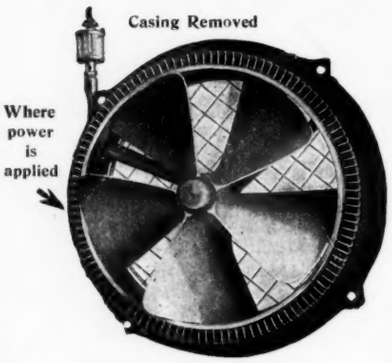

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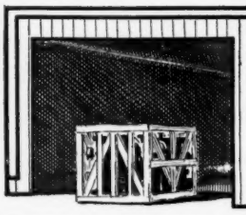

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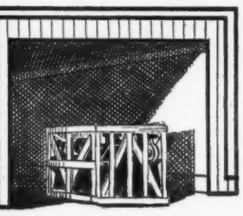

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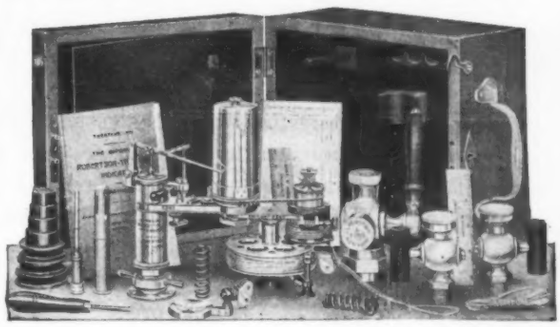

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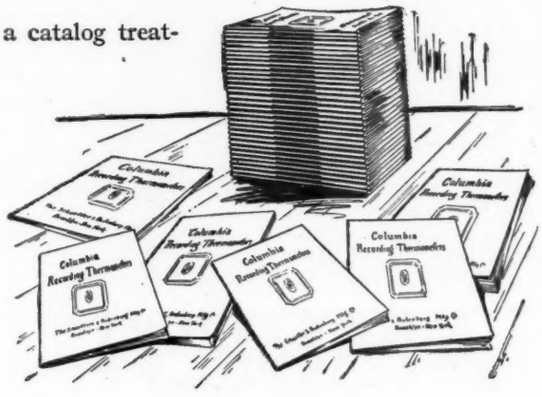

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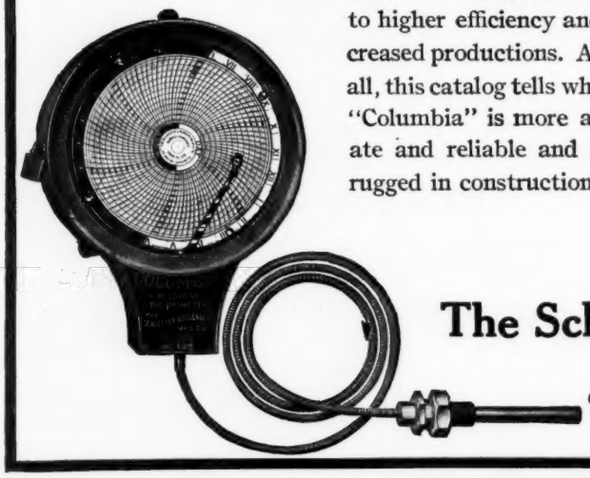

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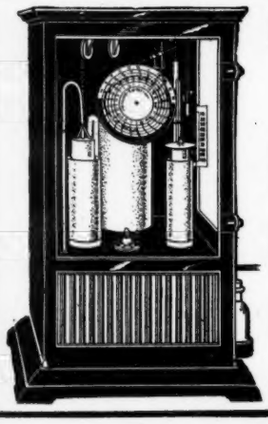

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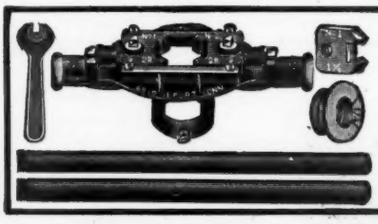

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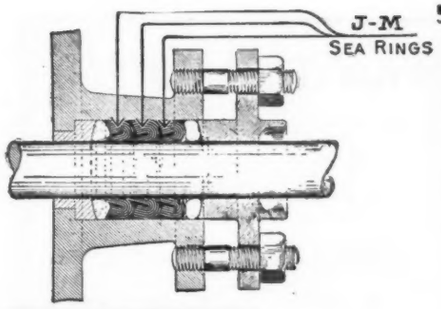

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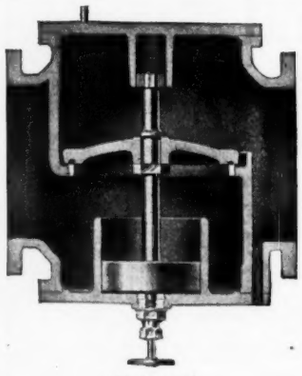

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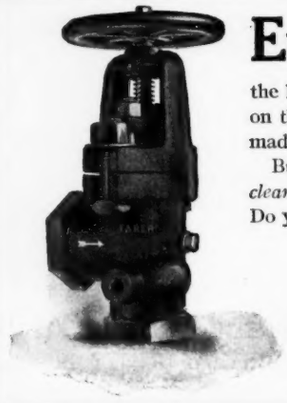


Everybody Knows

the life of a Blow-Off Valve depends on the *seat*. That is why seats are made *reversible*.

But the **FABER** *automatically cleans* its disc and seat while closing. Do you get that?

A Bulletin will tell you more.

Elliott Company
6920 Susquehanna St.
Pittsburg, Pa.

No Matter What Size or Kind of Reducing Valve You Need

you will find your needs exactly filled by some one of the Mason Line. For **Mason Reducing Valves** are not only Standard in quality, but also built to fit every case. A post card brings catalog

MASON REGULATOR COMPANY
Advance and Medway Sts. **BOSTON, MASS.**

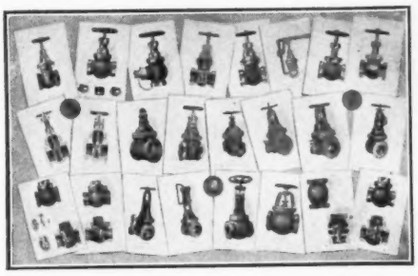
A BIG VALVE IMPROVEMENT

The Loose Neck Gate of the Monarch Loose Neck Gate Valve. It's a feature that you *ought* to know about.

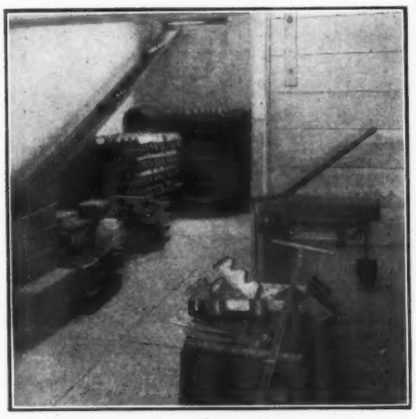
A post card brings free booklet giving full details.

MONARCH VALVE & MFG. CO.
476 Main Street **Springfield, Mass.**

The Valves That Are Test-Built



These are the valves that are test-built.



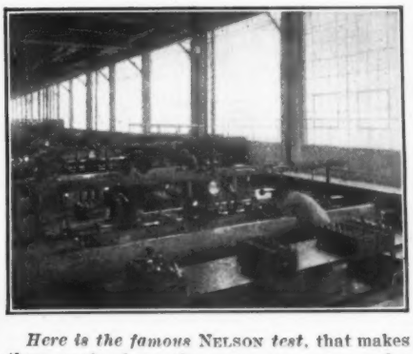
This is the copper and lead and tin—*to make the valves that are test-built.*

These are the fires, where we begin, to melt the copper and lead and tin—*to make the valves that are test-built.*

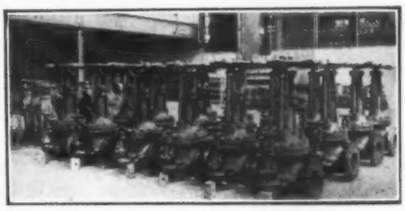
Here are the moulds, laid straight and neat, in a comfortable place away from the heat *of the furnace fires where we begin,* to melt the copper and lead and tin—*to make the valves that are test-built.*

These fine machines, in several rows, finish the parts as you suppose, *that came from the moulds laid straight and neat,* in a comfortable place away from the heat *of the furnace fires where we begin,* to melt the copper and lead and tin—*to make the valves that are test-built.*

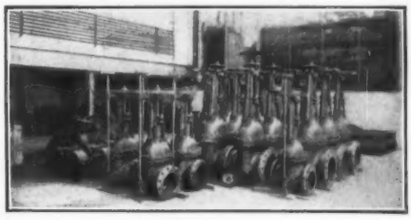
Here are the benches, where you see, the parts as fine as fine can be, *and all alike, so they will fit,* and you won't have to bother a bit, *to get another exactly so,* for they will nice together go; *for fine machines, in several rows,* finish the parts as you suppose, *that came from the moulds laid straight and neat,* in a comfortable place away from the heat *of the furnace fires where we begin,* to melt the copper and lead and tin—*to make the valves that are test-built.*



Here is the famous NELSON *test,* that makes them rank above the rest; *for every valve must be all right,* and in the test be proven tight. *And to prevent the slightest trouble,* we run no risk, but test them double. *The* NELSON *plan is to protect* you from the flaws we can't detect, *when at the benches, where you see,* the parts as fine as fine can be, *and all alike, so they will fit* and you won't have to bother a bit, *to get another exactly so,* for they will nice together go: *for fine machines, in several rows,* finish the parts as you suppose, *that came from the moulds laid straight and neat,* in a comfortable place away from the heat *of the furnace fires where we begin,* to melt the copper and lead and tin—*to make the valves that are test-built.*



And now the valves are ready to ship!
A word from you will give us the tip.
By express or freight, just as you say;
They'll make you glad for many a day.
And don't forget to tell the boss,
The valves to stop his power loss,
Must have the famous NELSON test,
That makes them rank above the rest;
For every valve must be all right,
And in the test be proven tight.
And to prevent the slightest trouble,
We run no risk, but test them double.
The NELSON plan is to protect
You from the flaws we can't detect,
When at the benches, where you see,
The parts as fine as fine can be,
And all alike, so they will fit
And you won't have to bother a bit,
To get another exactly so,
For they will nice together go;
For fine machines, in several rows,
Finish the parts as you suppose,
That came from the moulds laid straight and neat,
In a comfortable place away from the heat
Of the furnace fires where we begin,
To melt the copper and lead and tin—
To make the valves that are test-built.

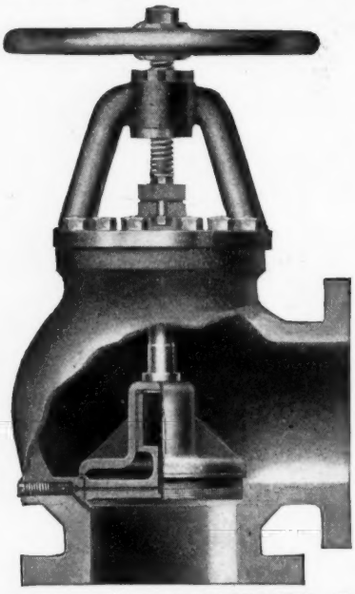


Plant of the

Nelson Valve Company

Philadelphia

Bradford Automatic Non-Return Boiler Stop Valve



Assures safety and economy in the boiler room. If one unit is disabled the Bradford Stop Valve will cut out the injured boiler and permit the balance of the battery to assume the full load. It saves shutdowns, burning plates, hauling fires; it safeguards life and property. Write for catalog.

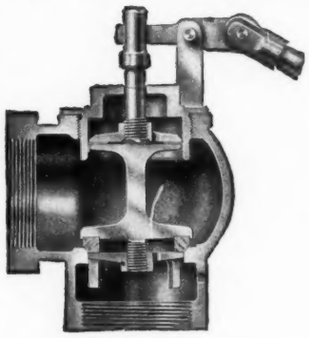
Agents Wanted In Every City

JNO. B. PERKINS COMPANY

141 Milk Street, Boston, Mass.

Jno. B. Perkins Company, 925 Chestnut St., Philadelphia, Pa.
W. D. Garret & Co., 136 Liberty St., New York

Try It 30 Days At Our Expense



It is made on the single seat balanced principle—a positive seat is always assured.

It prevents the water from running low or flowing over the tanks, it does its work reliably without attention.

The Schade Balanced Float Valve

The disc and balancing piston leather are renewable at slight expense and without taking valve off the line.

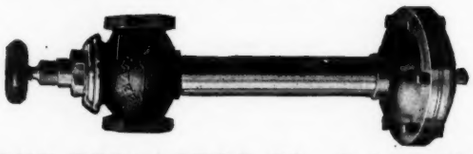
Operates without water hammer or chattering. *Write for Catalog and prices.*

Schade Valve Manufacturing Co.

2530 N. American Street Philadelphia, Pa.

—USE—

"BEATS ALL" REDUCING VALVES



LOCKE REGULATOR CO., Salem, Mass.

Something Of Interest To All Users of Reduced Pressures

A Reducing Valve that gives absolute accuracy and has

No Diaphragms,
No Weighted Levers,
No Inside Springs.

Ask for Bulletin.

ELLIOTT COMPANY

6920 Susquehanna Street, Pittsburg, Pa.

Never Get Stuck

New Bedford Whale Brand Valves are as perfectly constructed as it is possible for valves to be regardless of cost. Do yourself the justice to investigate.

New Bedford Valve Manufacturing Co.,

Established 1872 New Bedford, Massachusetts

Unlike Globe And Gate Valves

The Homestead Valve Seat is absolutely protected from wear as the pressure passes through it.

Homestead Valve Mfg. Co.,

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THE **CHAPMAN VALVE** MANUFACTURING COMPANY

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BRASS AND IRON VALVES

For Steam, Water, Gas, Oil, etc. Sluice Gates

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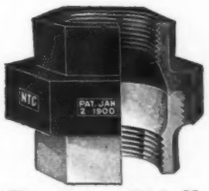
Valves and Fittings

All Sizes For All Purposes

Complete Piping Systems

Pittsburgh Valve Foundry And Construction Co., Pittsburgh, Pa.

Don't Use Untested Unions



"The Union With No Inserted Parts"

The ***"Kewanee" Union*** is given a severe test before leaving the factory—125 pounds compressed air pressure under water. No hidden leak can escape this test. Ask for booklet, THE WHOLE KEWANEE FAMILY.

National Tube Company
Pittsburgh, Pa.

The Forbes
Motor Driven Pipe Cutting and Threading Machine

is a time saver, a labor saver, a power saver. Can be taken to the job, one man can operate it, power can be shut off when machine is not in use.

Write for full details.

The Curtis & Curtis Co.
85 Garden St.,
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For High Pressure Steam Piping

Whitlock
DOUBLE-LAPPED
Joints

The strongest and most durable form of joint ever devised. The double lapping process enables Whitlock Joints to give tight service with least weight of pipe. Made in full weight steel pipe for working pressures up to 250 lbs. per square inch.

Write for Catalogue with full details.

The Whitlock Coil Pipe Co., Hartford, Conn.
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Trill Indicators are Guaranteed For A Lifetime of Accurate Service

Trill Indicator Co.
Corry, Pa.

The guarantee that goes with every Trill Indicator is the strongest guarantee ever given by any indicator manufacturer. It insures you a lifetime of complete satisfaction.
Trill Triumph Indicators represent the height of skilled workmanship. They are Indicators of "Quality," through and through—instruments which you will be proud to own and use. For accurate results Trill Triumph Indicators lead the field. Engineers who have bought more expensive outfits have regretted that they did not know about Trill Quality before purchasing the more expensive instruments.

YOURS FOR $5 DOWN AND $5 A MONTH

Moreover we will send you a Trill Outfit subject to approval. We know the Trill will make instant friends as soon as you take it out of its handsome case.

Trill Indicator Co., Corry, Pa.

Please send me the full story of Trill Triumph Indicators, together with a copy of your guarantee and selling plan.

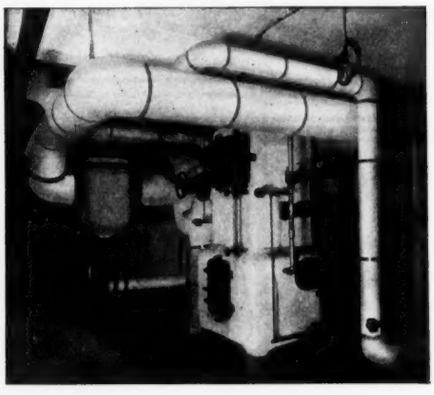
Name.....

Address.....

This Ad Introduces POWER Readers To A New And Different Hot Pipe Covering

Nonpareil High Pressure Covering

Ages ago in the sea and lake bottoms there existed microscopic plants known as diatoms. Their skeletons or shells today form what is called diatomaceous earth—a material which is practically pure silica. This earth combined with asbestos fibre makes Nonpareil High Pressure Covering.



Nonpareil covering is new but thoroughly tried. The illustration shows an installation on Steam Lines and Heater, Paterson General Hospital, Paterson, N.J.

The little skeletons composing diatomaceous earth (there are billions to the cubic inch) are all hollow and contain air.

That's the reason Nonpareil High Pressure Covering is so efficient as a nonconductor of heat. It contains more entrapped air than any of its competitors.

While insulating efficiency (keeping the heat in) is of the greatest importance in any hot pipe covering, there are other essentials.

You will find that Nonpareil Covering withstands temperatures at which other coverings calcine and disintegrate—

That it is not affected by water or steam—

That it is just as easy to apply and equally reasonable in price. Send for a sample.

The history of Nonpareil Covering makes a wonderfully interesting story for the power plant man. We've told it complete in our Catalogue S-11. Send for a copy today.

Armstrong Cork Company
Insulation Department
Pittsburgh, Pa.
Branch Offices in the large Cities.

The Original and only Manufacturers of

The Dart Union

TWO Bronze Rings, spherical in form, in combination with malleable iron pipe ends, is our method of making tight joints and winning a reputation.

Ask for the Booklet.

E. M. Dart M'f'g Company, Providence, R.I.
Canadian Factory: Dart Union Co., Ltd., Toronto.

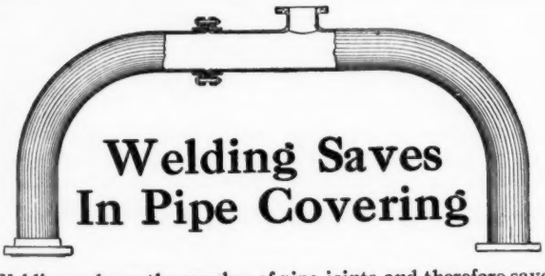
"The Union with no inserted parts"

Every "Kewanee" Union Is Tested

to 125 pounds compressed air under water. No imperfect union can pass this test.

Ask for the booklet,
THE WHOLE KEWANEE FAMILY

NATIONAL TUBE CO., Pittsburgh, Pa.



Welding Saves In Pipe Covering

Welding reduces the number of pipe joints, and therefore saves in first cost of covering, there being fewer fittings and flanges to be covered. Our Catalog No. 27 will be mailed on request.

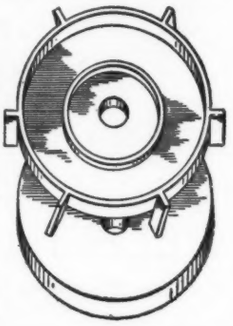
The M. W. Kellogg Co., 50 Church Street New York

Longer Service From Pump Valves

by installing **Cooley Valve Rotors.** These practical Rotors by assuring equal wear on all parts of the valve eliminate valve leakage, thus decreasing the slip on the pump.

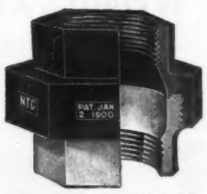
They not only save on valve costs and reduce valve troubles, but they increase the efficiency of the pump, save steam and coal, and reduce wear and tear of the pump.

Write for full details.



Cooley & Milligan
302 Ford Bldg., Detroit, Mich.

"None Better"



"The Union With No Inserted Parts"

than **"Kewanee" Unions**—then why experiment with other kinds. THE WHOLE KEWANEE FAMILY is an illustrated booklet with plenty of information about "Kewanee" Fittings. It's free but you must ask for it.

National Tube Company
Pittsburgh, Pa.

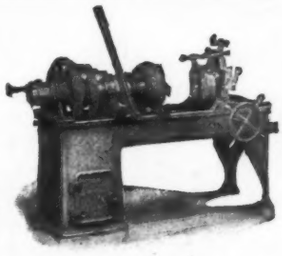
YOU WILL FIND
That Efficiency Is The Ear-Mark Of "Toledos." Thousands Will Vouch For This

TOLEDO NO. 2
THREADS 2½"
TO 4" PIPE. EASILY

Write For "A Pipe Threading Miracle."

THE TOLEDO PIPE THREADING MACHINE CO., TOLEDO, O.

When It Comes To Pipe Threading—



the B&K Pipe Machines leave all others way behind. In rapid production, ease of operation, and clean, accurate work they are unexcelled. If you'll study the details of construction you'll understand why. The Peerless Die Head, in itself, tells a lot. Nine sizes.

Catalog for the request.

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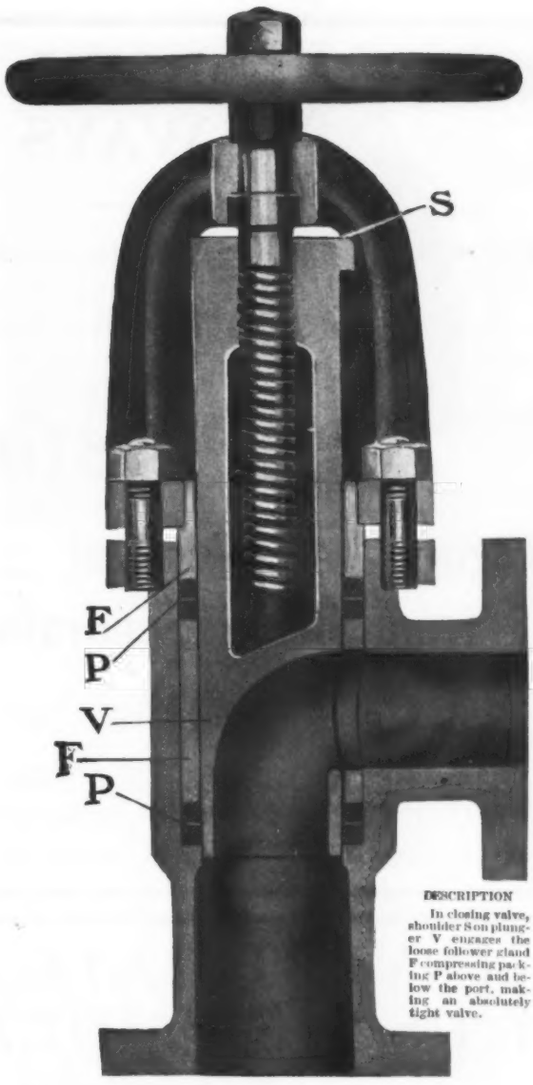


DESCRIPTION
In closing valve, shoulder S on plunger V engages the loose follower gland F compressing packing P above and below the port, making an absolutely tight valve.

SIMPLEX
SEATLESS BLOW OFF VALVE

3 NOTEWORTHY FEATURES

First: **THE SIMPLEX BLOW-OFF VALVE,** has no seat to cut and clog with scale and dirt; the valve stays tight, saving expense of leakage and repairs.

Second: In the **SIMPLEX SEATLESS BLOW-OFF VALVE** the Packing P is always protected from the destructive blast of the blow-off—whether this valve is wide open or only open part way.

Third: In the **SIMPLEX SEATLESS BLOW-OFF VALVE** the packing is automatically tightened. When the valve is closed lug S forces the sleeve F against packing P.

Send for letters from actual users which show the big saving of the **SIMPLEX SEATLESS BLOW-OFF VALVE,** together with full information.

Sign and mail us the attached coupon—right away.

Yarnall-Waring Co.
1111 Locust Street
Philadelphia, Pa.

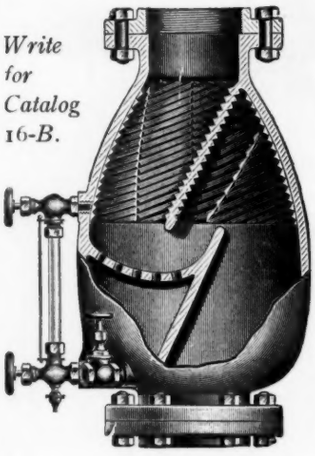
Also makers of the SIMPLEX PIPE CLAMP, the "LEA" WATER FLOW RECORDER, and the SIMPLEX CASKEY PRESSURE PACKED VALVES.

COUPON. SIGN HERE

Gentlemen: You may send me complete information regarding **Simplex Seatless Blow-Off Valves** and put my name on your mailing list for copy of the "The Blow-Off."

Name .....
Address .....
Firm Name .....
Adv. P. 12-26-11.

Write for Catalog 16-B.



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We ship on trial and pay transportation both ways if the

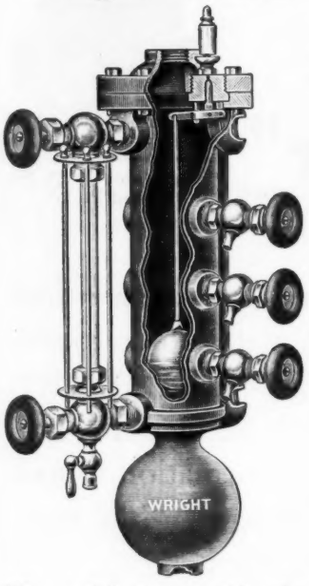
Austin

Figure "A" Vertical Iron Steam Separator

fails to give satisfaction. Its use is a guarantee of DRY STEAM.

Austin Separator Company
157 Woodbridge St. Detroit, Mich.

"Wright" Alarm Water Columns



Approved by all Government and Municipal Inspectors.

A Simple, Economical and Dependable means of Insurance against Boiler Disasters.

We ship on trial.

The whistle shrieks before the real DANGER point is reached, thus giving the attendant time to overcome any possible trouble. Write for Catalog C-50.

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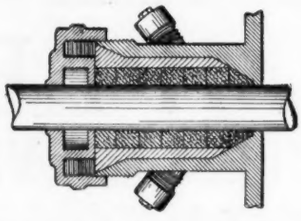
INVESTIGATE THIS NEW IDEA



Nothing Like The Short Flexible Packing Box Ever On The Market Before

Saves its cost in few months, by cutting packing bills 75%.

The flexible adjustment controls the packing so that it holds the steam but does not grip the rod too hard.

Allows packing to remain soft and pliable until worn out. Will make any kind of packing last longer. 60 *days' trial offer.* Saving guaranteed. **Write for bulletins.**

Short Flexible Stuffing Box Co.
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Lytton Traps are made in all styles for all purposes. We claim that they are the highest quality in every respect and back up our claims by sending any trap on 30 days' free trial. Lytton Traps tried in a plant mean Lytton Traps used in that plant.

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LYTTON MANUFACTURING CORP.
Room 1159 Hudson Terminal Bldg. New York City
Makers of Lytton Return Traps, Lytton Vacuum Traps, Lytton Separating Traps, Lytton Lifting Traps, Lytton Pressure Reducing Valves, Lytton Blow-off Valves.
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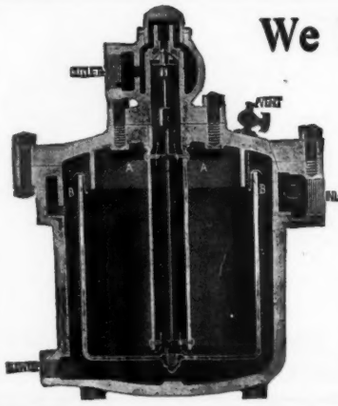

We Pay Freight

both ways if you are not satisfied with the

"Stickle" Steam Trap

We guarantee 25% greater efficiency than any other trap on the market. Why not try a "Stickle" at our expense for 30 days? Send for further details.

Open Coil Heater and Purifier Co.
502 S. Pennsylvania Street,
Indianapolis, Ind.

Write For A Copy Of The BUNDY Trap Book

Gives complete details of the different styles of **Bundy Traps.** Contains 64 pages of interesting trap information with many illustrations of typical installations. A copy will be sent to you on request.

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Works: Nashua, N. H. Sales Office: 127 Federal St., Boston, Mass.

Make Your Plant More Efficient—The

S & S TACHOMETER

is the accurate way of determining and maintaining proper speeds of power producing machines and speeds and feeds of power using machines. Handy; portable; easy to operate; one spindle for all ranges of speed. *Write for catalog.*

Schuchardt & Schutte, West Street Bldg., New York

Practical and Economical Method of Handling Coal and Ashes in Modern Power Plants.

Jeffrey Coal and Ashes Handling Equipment at Peoria Gas and Electric Co., Peoria, Ill. Grab Bucket carries coal from cars, or storage pit, to hopper, which delivers to Belt Conveyor, discharging coal over bunkers. This equipment also handles ashes from pit to railway cars.

Write for copy of Catalog No. 32. telling about the services of this and various other Coal and Ashes Handling Installations made by us.

JEFFREY MFG. CO., COLUMBUS, O.

New York, Boston, Montreal, Pittsburgh, Charleston, W. Va., Atlanta, Ga., Birmingham, Chicago, St. Louis, Denver, Seattle

12-26-11

The GENUINE SQUIRES STEAM TRAPS FOR SERVICE

Patented Double Valve.

The Double Valve Mechanism is Interchangeable with the Regular Valve and Seat as Illustrated Below

The merit of the SQUIRES GENUINE Steam Traps has repeatedly been demonstrated in high pressure power plants, low pressure heating systems and many other places where steam traps have been required to remove the water of condensation without the escape of steam. Let us send you one or more subject to your approval.

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THE C. E. SQUIRES CO., East 40th St. and Kelley Ave. Cleveland, O.

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GENUINE EUREKA Gum Core Packing

is suited to pressures up to 100 lbs. better than any other you can obtain.

Won't you please send for a sample and catalog which will not only explain but show you why GENUINE EUREKA is best.

These will give you information enough to satisfy any engineer and make him know that the soft packing that costs less and proves best is Genuine Eureka.

You know the least work for you, the better you can do what is outlined for you and a packing which will keep tight joints without scoring, scratching or binding rods, at a moderate cost is a packing which saves you time and your boss money.

Your dealer carries Genuine Eureka—get it from him or send direct to us. We pay carriage charges on 10 lbs., or over anywhere East or South of Omaha. Please put your order in for trial lot.

The other styles of Eureka Packing which will deserve your investigation, are Eureka Spiral, High Pressure Ring, Expansion Ring, and Red Core Ring—all of the better value and lower cost.

Our Eureka catalog will interest you.

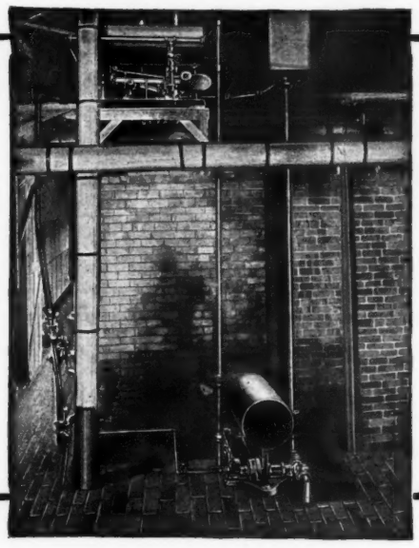
The Eureka Packing Co.

Jas. L. Robertson, Pres.

76-78 Murray Street **New York City**

Morehead Condenser Trap

installation on the boilers of the Maumee Brick & Tile Co. Plant, Fort Wayne, Indiana.



This proposition means money for the management and satisfaction to the engineer. Write for Free Book.

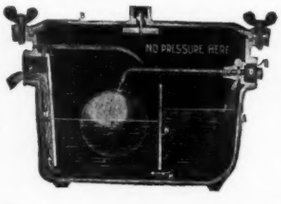
Morehead Manufacturing Comp'y

Dept. "E," DETROIT, MICHIGAN

Stocks carried in: New York, Philadelphia, Memphis, Tenn., Birmingham, Ala., San Francisco, New Orleans, La., Wichita, Kan., Los Angeles, Chicago, Chatham, Ont.

Did You Ever Realize

the best machines to do work are those which have the least number of parts and accomplish the results in the simplest way?



These features are characteristic of our STEAM TRAPS.

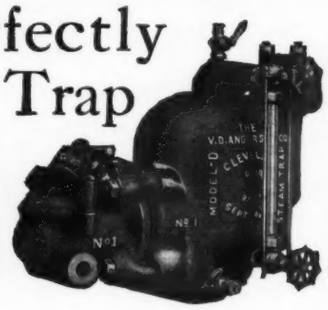
Elliott Company

6920 Susquehanna St.

Pittsburg, Pa.

The Perfectly Reliable Trap

The Anderson Improved Steam Trap delivers exhaust water against any back pressure five pounds less than the steam pressure at the trap. Steam cannot escape from it—water must. Booklet?

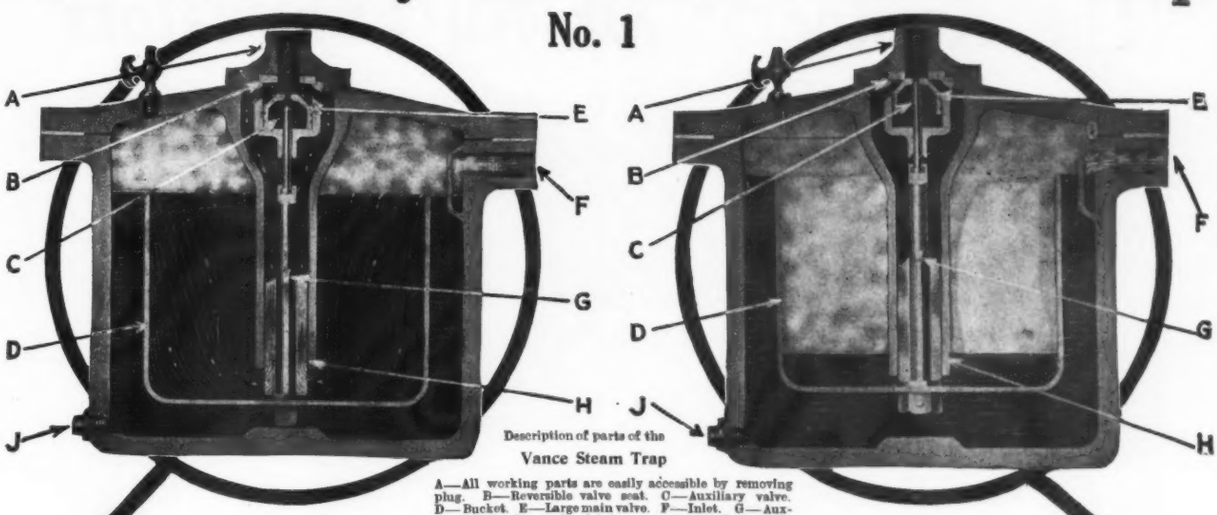


The V. D. Anderson Company,

1935 W. 96th Street, Cleveland, Ohio

The Economy Of Vance Steam Traps

No. 1



Description of parts of the Vance Steam Trap

A—All working parts are easily accessible by removing plug. B—Reversible valve seat. C—Auxiliary valve. D—Bucket. E—Large main valve. F—Inlet. G—Auxiliary valve has a slip joint connection to the winged guide and is guided true to seat by the cage. H—End of discharge tube always water-sealed. J—Blow-off.

If You Had Two Traps,

and could do the same work better with one— or if you had five traps and could do the work better with two, it would save you money, wouldn't it ?

That is just what **VANCE STEAM TRAPS** will do for you, because they have *a valve area that is four to ten times greater* than any other trap of equal rated capacity.

Therefore, if you want a trap to take care of the condensation of a pipe, the **VANCE** Trap you buy will be very much smaller and cost you very much less.

Or, if you want a trap the same pipe size as the one you now have, if it is of the float or bucket type, the **VANCE** Trap will take care of three to five times the condensation your present trap is handling.

However, to convince you that the **VANCE** and its remarkable double valve *will* handle all this condensation, let's get right down to actual figures, and prove it.

The diameter of the valve area of all other prominent float and bucket traps run from 1/16 to 9/16, according to size, set to work at 100 lbs. pressure.

The diameter of the valve area of the **VANCE** set for same pressure runs from 3/8 to 1 3/8.

But, even if you take your own trap, measure the valve opening — compute area — compare with the **VANCE** of same size inlet, and find out that our claims are well on the safe side of actual conditions—a **VANCE** Trap will not save you a cent, unless you *use* it.

Now —

We're willing to go half way — send you a **VANCE** on

30 days free trial

express charges prepaid, so you can use it. See it demonstrate this economy right in your own plant. *If, however*, you would like to know more about the detailed construction before sending for trap — sign and mail this coupon for useful 64 page

Free Engineers' Reference Book and VANCE Steam Trap Catalog

Send it off to us to-day — sometimes it's overlooked, so mail this coupon *now*.

SIGN THIS COUPON

Gentlemen: Please forward by return mail Free Engineers' Reference Book.

Name .....

Position .....

Home Address .....

Firm .....

Firm Address .....

No. of traps in use .....

Dealer's name .....

P. 77

Geo. M. Newhall Engineering Co.

Department of Supplies

150 South Fourth Street **Philadelphia, Pa.**

Sales Agents: Chicago, T. J. McMaster. New York, W. D.Garrett & Co. St. Louis, Wm. Kemp. Cleveland, Mau-Sherwood Supply Co. New Orleans, C. E. Keatly. Minn., W. A. Sharp. San Francisco, H. K. Moulthroup. Denver, Onderdonk Engineering Co. New Haven, C. S. Mersick & Co.

If your dealer hasn't the VANCE send us his name and we'll send him full information.

"The Aristocrat Of All Lubricators"

The only lubricator that employs the *"little drop of oil per stroke principle."*

This principle is fully described in Treatise M53 on "Cylinder Lubrication." Send for it to-day; it's mighty interesting

THE RICHARDSON-PHENIX CO.

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No. 53

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for better nourishment is a call to the mother for better food. The engine's groan for better lubrication is a call to the engineer for

Dixon's Flake Graphite

No other lubricant can perform the service of flake graphite. It builds the rough metal surfaces with a smooth, durable veneer-like coating of graphite and prevents the ruinous metal-to-metal contact. Write for booklet and free sample No. 94c.

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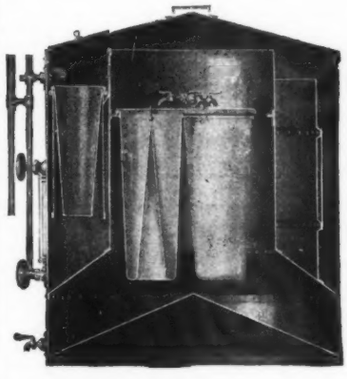

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a Liberty Oil Purifier will restore original efficiency to your used lubricating oils?

A Bulletin will tell you all about it.

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The Unbreakable Gage Glass

Two tubes fuzed into One

Send for a dozen

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TRADE MARK REGISTERED NON-FLUID OIL UNITED STATES PATENT OFFICE

Saves money and trouble by not running off bearings like fluid oil, nor increasing friction-load and wasting power like grease.

Free sample by paid express on request.

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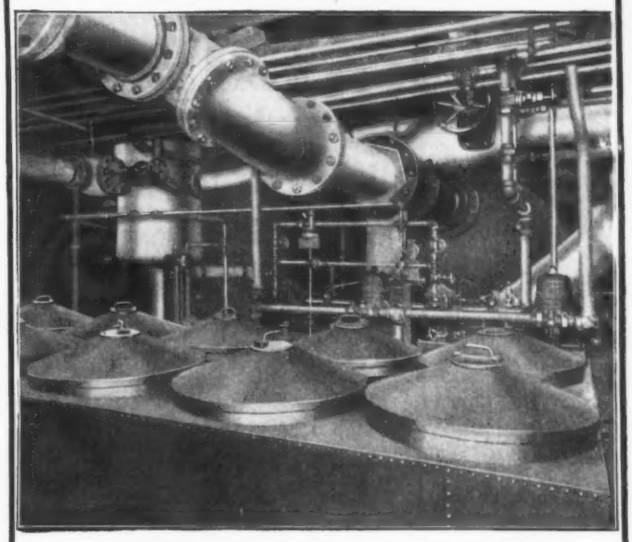

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Reduce the Cost of Your Power With a

Bowser Oil Filtration And Circulating System

Kent says that friction can be reduced about one sixth with steam oil feed. On this basis how much could you save per year per h. p.?

In the purchase of an oiling system you want the best at the lowest cost and cost should be figured on sq. ft. of filtering surface.

The Bowser System provides 3 sq. ft. of filtering surface for each gallon of oil per hour to be filtered.

It has an available pressure head of 3 ft. which is exerted over the entire filter surface.

All tanks, filters, oil lines, etc., are easily accessible and can be cleaned while the system is in operation.

The Bowser can supply oil from ten to fifteen hours without operating pumps or filters.

There are many more advantages which are exclusive with the Bowser. Don't pay any price for an oiling system until you have investigated the Bowser.

Ask for Catalogue No. 72.

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Oil Separators

that can be cleaned without breaking a pipe connection; without flat plates to increase the back pressure. That is our type "N." Do you want to know more about it and other types?

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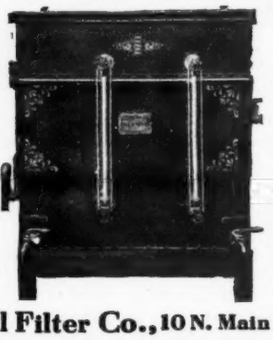
The Dry System of Oil Filtration is the only one approved by the U. S. Government.

The Franklin Oil Filter Is The Only Dry System Filter on the Market

Send for free booklet on Oil Filtration



We guarantee a saving of 70% of your oil bill. 30 days' trial.

Adopted in 83 departments of the U. S. Government exclusively.

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ONE Ounce of Albany Grease Will Do More To Minimize Friction Than 4 Times Any Other Lubricant.

Albany Grease is a pure tallow grease. It feeds and stops automatically, as much or little lubricant as the moving parts require, YET does not require any attention from you. It is all lubricant with no waste.

No matter where or on what machinery you have a lubricating problem, there is an

ALBANY GREASE

Number to solve that problem. To reduce friction—to save power—and to save coal—because Albany Grease can NEVER waste, drip or spatter.

It saves time for the engineer, because he has no drip pans to look after; it saves the cost of waste because the engine parts never need wiping, as they always do and always will wherever oil is used.

If you want to test Albany, the Grease of ultimate economy, send for a liberal sample and Albany Grease cup. Our Free Booklet, "Economic Lubrication," sent upon request.

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ADAM COOK'S SONS, PROPS.

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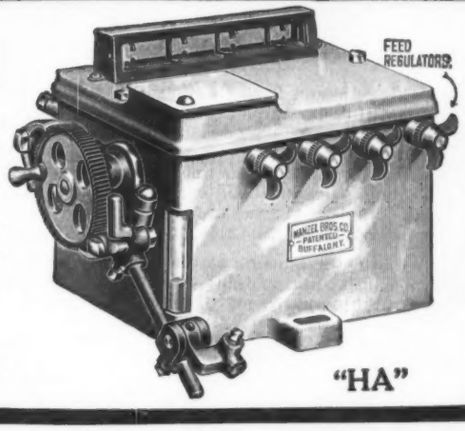
Better Lubrication—Less Oil

With a Manzel New Model Oil Pump on the job the cylinder will always secure the lubrication it needs, no more or less. You regulate the feed by the speed of the engine, four drops per minute or, if required, a stream with every stroke. You are assured of *positive lubrication* regardless of the conditions of the weather, the speed of the engine, the pressure on the boiler, or the grade of oil. You save 30 & 60% on your oil bill—you get better results.

Let us ship you a Manzel on 30 days' free trial. Write for catalog No. 15.



"HA"

Manzel Brothers Company

326 Babcock Street, **Buffalo, N. Y.**

THE DETROIT

A Positive Lubricator

Depending upon natural laws for operation, Detroit Sight Feed Lubricators are absolutely positive in their action.

There is nothing haphazard about their operation. They enable you to know with absolute assurance that every part of your machine is being oiled just as it should be.

Cut shows the new member of the Detroit Family—the Detroit Air Compressor Lubricator. It is of standard Detroit Quality.

Our Catalog A-4 is sent on request.

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SHERWOOD DOUBLE TUBE INJECTORS

HIGH GRADE—HIGH DUTY

Wide pressure range—15 to 200 lbs

Operated by one lever.

No valves required.

Long and continuous service.

Guaranteed.

Write Dept. "E" for Catalog

Manufactured by

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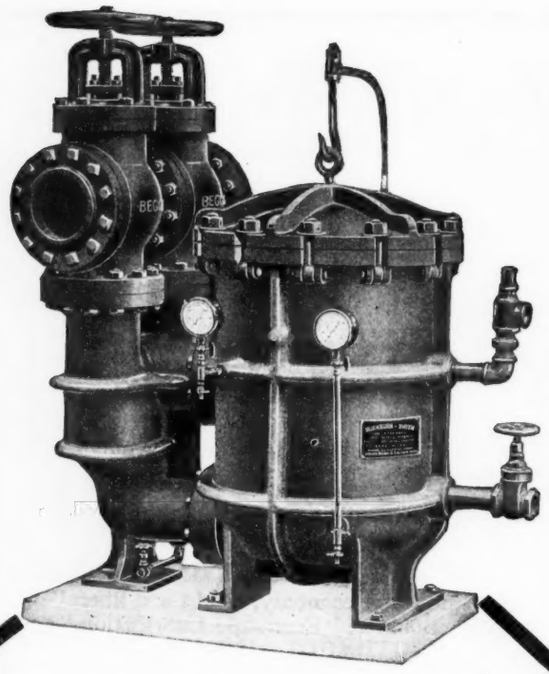

This should interest you if your feed water is muddy or oily.

"This filter has given us excellent results at the plant of the W. & J. Knox Net and Twine Co., and we cannot see how we can very well get along without it at the present time."

This comment from the Consulting Engineer of all the constituent companies of the Linen Thread Company was written after he had tried salt, hay, excelsior, bone black, sand and burlap, all of which failed to remove oil particles from the the condensation. The Blackburn-Smith Filter, on the other hand, did its work so well that complete payment was made before the expiration of the trial period.

We can cite numerous other cases where a Blackburn-Smith Filter is doing good work in plants where other filtering media and devices have failed to keep oil out of the boilers. We can quickly explain why no other device offers such good protection where the feed is contaminated by oil from the open heater or hot well, or where the water supply contains slime, mud or other floating particles. Perhaps you would be convinced beforehand that double filtration through separated Terry cloths, our system of small, easily handled filtering cartridges, our facilities for quick, easy and thorough cleaning and the low upkeep expense of the Blackburn-Smith apparatus offer the logical solution to filtering problems.

But better than this, tell us fully about your feed water conditions. If the Blackburn-Smith Filter offers the remedy we will send you one to try. If a 60 days' service test does not prove to your satisfaction that the filter soon saves its cost, you can send it back. This offer is open to all responsible parties. Shall we send book "Feed Water Filtration"?

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37 Warren Street New York

Agents in all principal cities of U. S. and Canada.

84a

If *You* Point the Way

to a *better* light and power service at a lower cost

Who Gets the Credit?

¶ Most certainly the man who shows the owner of the building how to improve the service and decrease the cost.

¶ The only question confronting you, Mr. Chief Engineer, is—are *you* going to be the man who points the way, or are you going to wait for some one else to do it, and so take from you the credit which *ought* to be yours.

¶ Suppose that your employer, *himself*, becomes interested in the economies and the improvements made possible through Central Station Service, investigates and finds that he actually *can* save money by making a change.

¶ One of the first questions that will come into his mind will be why *you*, the man whom he is paying to see to it that he gets the *best service* at the *least cost*, did not recommend this more efficient and more economical method.

¶ And what answer *could* you make to this question?

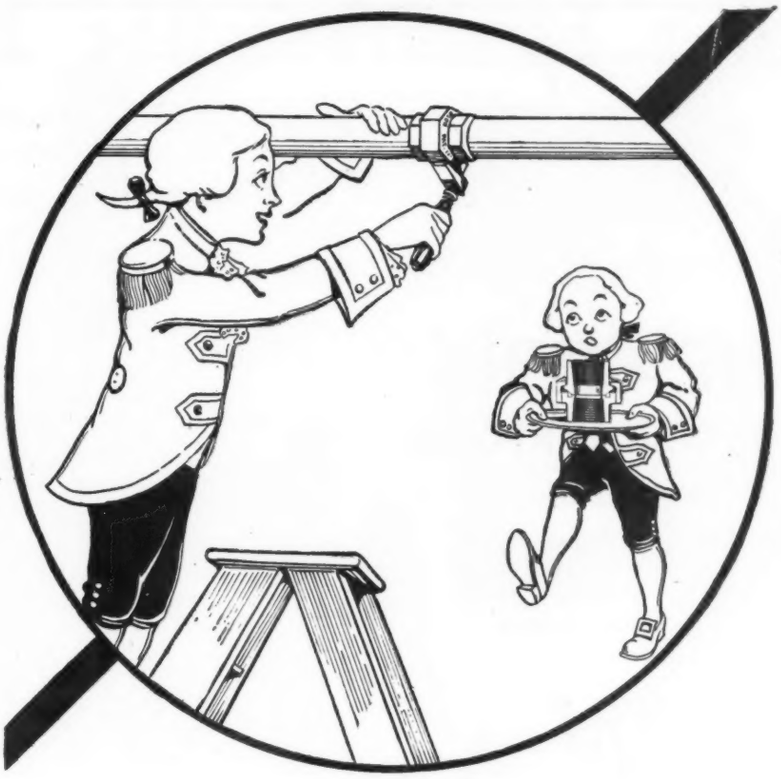
¶ You could not very well reply that you had not had an opportunity to look into the matter, for the opportunity is wide open—the way is easy.

¶ Nor could you simply say that you had not thought that Central Station Service was more efficient and more economical. For it is your job *to* think.

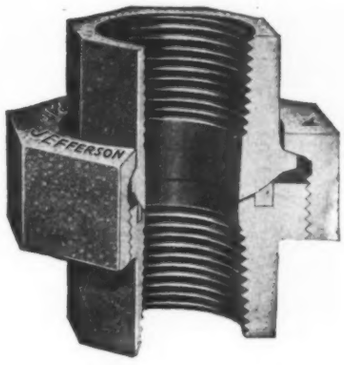
¶ But if *you, yourself*, recommend the more efficient and economical way, there will be no comeback. Instead, the credit will be *yours*—as it should be.

The thing for you to do is to get full details. Write us—or 'phone "Worth 3000"—and we will gladly go into the matter fully.

The New York Edison Co
55 Duane Street New York



ALL'S WELL WITH JEFFERSON UNIONS



WHEN you put **Jefferson Unions** on a pipe line, you put that pipe line out of your mind. Every joint is tight, and stays tight.

FEATURES

The ring of necessary brass in the **Jefferson Union** is set in the iron of the female member, protected from pipe contents and the action of rapidly changing temperatures, as well as from danger of jamming by the ends of the pipe, no matter how far these are screwed in. Result—A joint that does not corrode. The brass cannot expand or contract rapidly and cause leaks. Other features are the ball shaped shoulder and coarse nut threads, permitting quick adjustment. These are coated with graphite as protection against corroding. Made throughout of the best material, embodying new distinctive features, adaptable for use under any conditions. **Jefferson Unions** are all around the best investment for the progressive power plant. Try them. Put the proof up to us.

Fill, cut out and mail the coupon to the right. It will bring you Bulletin "A," and the new book on the elimination of steam line troubles. Yours for the asking.

Jefferson Union Co., Lexington, Mass.
Dear Sirs:—Send me a copy of Bulletin A and put my name down to receive your new book on eliminating piping troubles, when it is off the press.

Name. . . . . .

Firm Name . . . . . .

Address . . . . . .

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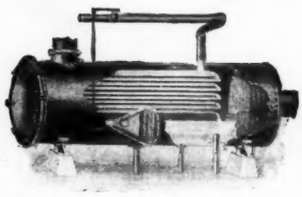


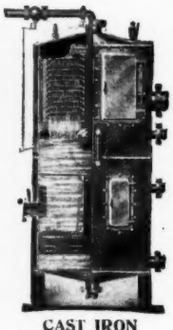
HORIZONTAL OPEN HEATER

Closed **Heaters**

PLAIN TUBULAR HEATER

HEATERS

FOR ALL PURPOSES



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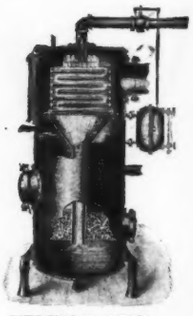

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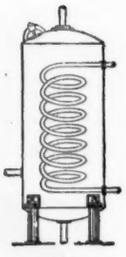


COIL HEATER

Separators
For
Oil

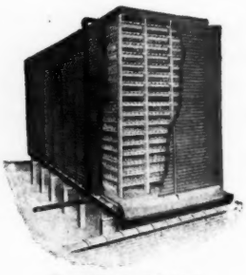
OIL SEPARATOR

Separators
For
Steam

STEAM SEPARATOR

BAROMETRIC CONDENSER

Condensers
For
Engines
Turbines



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Condensers
For
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CONDENSERS

FOR ALL PURPOSES

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A self-contained tank regulator

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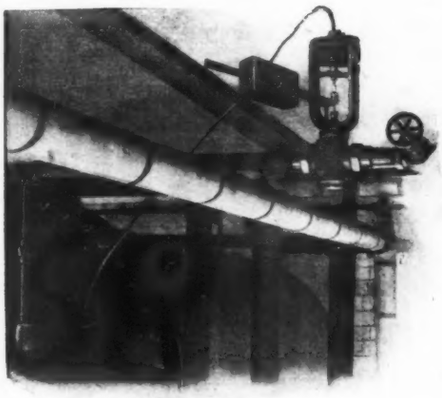

The stem, tube and bellows are filled with volatile liquid—insuring quick action of Regulator

there are no gutta-percha posts; no water or air pressure; no electricity or perishable diaphragms. All the action depends on the Sylphon brass accordion bellows which is sensitively flexible, strong and tight. It's the best regulating principle in mechanics—worth your investigation. Send for our latest Sylphon catalog.

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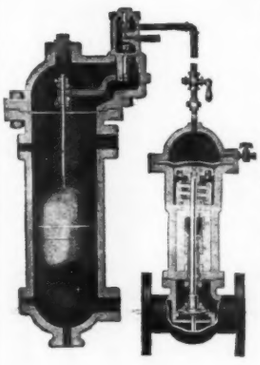

You Are Tired

looking at that water glass and trying to keep the valve and pump just right.

Don't you know it is easy to keep the water level just where you want it by using a **Liberty Feed Water Regulator?**

Elliott Company,

6920 Susquehanna Street,

Pittsburg, Pa.

DURABLA

the sheet packing that is ideal for high or low pressure. It stands 1000° heat.

Write for catalog and prices.

R. G. VON KOKERITZ & CO. 114 Liberty Street, NEW YORK

BELT DRIVEN MACHINES

1/4 TO 8 INCH PIPE

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The National Feed Water Heater

Six Good Sound Reasons Why *You* Should, At Once, Carefully Investigate The National.

Economy — In Coal, Floor Space, and Price Assured. No inside joints to leak. No straight tubes to leak. No back pressure is possible. No contact of the water with the shell or iron. No chance for grease in the boiler.

Let us send you our Catalog. It's yours for the asking.

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Stop Fuel Waste By Correctly Utilizing Your Exhaust Steam

Class "E C" Type—1000 to 2500 h. p.

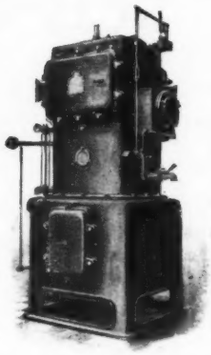
By properly using your exhaust steam to preheat the boiler feed water you save a large percentage of the fuel, because a part of its work is already done. This result you can get by installing the

Webster Feed Water Heater, And Oil Separator

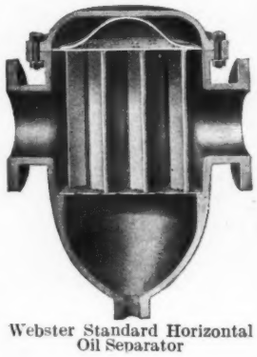
The Oil Separator removes all the oil and makes even the condensate perfectly pure and fit for boiler use. The water is heated by direct contact and none of the exhaust is wasted as in the "thoroughfare heater."

That the Webster Heater does its work with complete satisfaction is proved by the fact that over 5,000 installations have been made with no dissatisfied customers.

Ask for the free booklets describing Webster Heaters—also the Webster Vacuum System of Heating.



Class "E C" Feed Water Heater and Purifier 50 to 300 h. p.

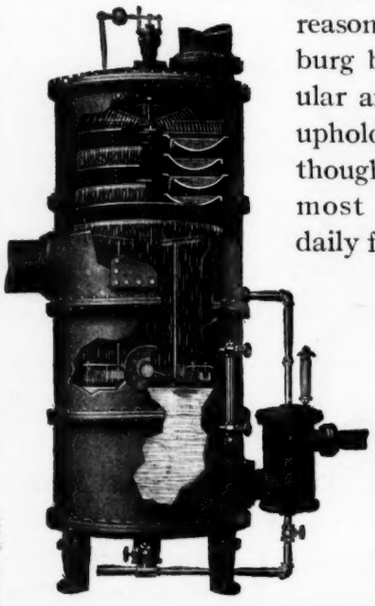


Webster Standard Horizontal Oil Separator

Warren Webster & Company
Camden, N. J.

This Will Help You

Cast Iron construction throughout in a Feed Water Heater, means freedom from corrosion. This means, the first cost is the last cost. That is one reason why the Pittsburg became so popular and continues to uphold its reputation though put to the most severe tests daily for fifteen years.



CATALOGUE 140

Elliott Company
6920 Susquehanna Street
Pittsburg, Pa.

60 Days' Free Trial

PATTERSON-BERRYMAN

So that you may know all its desirable qualities and valuable features we'll send you a Patterson-Berryman Heater on 60 days' trial. You need not risk a penny. Write for for our trial offer and our catalog.

Frank L. Patterson & Co.
28 Cortlandt Street
New York - - U. S. A.

The Blake & Knowles Steam Pump Works

BLAKE-KNOWLES

OPEN FEED-WATER HEATERS INCREASE BOILER EFFICIENCY
WRITE FOR BULLETIN BK 847-36
115 Broadway, New York Works: E. Cambridge, Mass.
B 139.1

ANNOUNCEMENT

Having purchased the entire outfit of the well known Bundy Steam and Oil Separators from The American Radiator Co., we are pleased to inform our patrons and friends that we are now marketing these separators through a chain of agencies established at central points, as per list following:

Charles C. Moore & Co.	San Francisco, and Los Angeles, California
Hampton-Fielding Eng. Co.	Denver, Colorado
Sumner Iron Works.	Seattle, Washington
Missouri Valley Eng. Co.	South Dakota
Geo. S. Thompson.	El Paso, Texas
Merrill P. Wolfe.	Dallas, Texas
Foot-Rolaff Mach. Co.	San Antonio, Texas
A. D. Grimes.	Oklahoma City, Oklahoma
Machinery Mfg. Co.	Portland, Oregon
W. H. Eddy.	Salt Lake City, Utah
Raymond F. Shank,	Des Moines, Iowa
Gore-Sewell Co.	New Orleans, Louisiana
Geo. K. Fitch.	Kansas City, Missouri
E. B. Totten Co.	St. Louis, Missouri
J. J. Domek.	Miles City, Montana
O. O. Howard.	Central City, Nebraska
Alamo Eng. & Supply Co.	Omaha, Nebraska
Brown-Roberts Co.	Alexandria, Louisiana
John T. Malone.	Atlanta, Georgia
J. A. Larson.	Asheville, North Carolina
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Northern Equipment Co.	Duluth, Minnesota
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H. DeNeefe	Chattanooga, Tennessee
Tri-State Eng. Co.	Memphis, Tennessee
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W. L. Berry.	Syracuse, New York
John T. Sadler & Co.	Elmira, New York
Schumacher & Santry.	Boston, Massachusetts
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D. Mac Arthur.	New Haven, Connecticut
A. W. Williams Machinery Co.	New Brunswick, Canada
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An examination of Bundy Steam and Oil Separators will indicate the fact that they produce the best results in operation, and effect economies which soon pay their purchase cost. We solicit your patronage and inquiries which will receive prompt and careful attention.

The Griscom-Spencer Co.

90 West St., New York

CENTRIFUGAL FORCE

The Distinctive Feature of the

SWARTWOUT

CAST IRON

EXHAUST HEAD

Centrifugal Force flings the water particles out of steam.

Centrifugal Force removes the water without causing back pressure.

The "Swartwout" exhaust head is of cast iron and lasts a lifetime. You can't buy a better exhaust head.

ASK FOR OUR MINIATURE CATALOG

THE OHIO BLOWER CO.

Centrifugal Steam and Oil Separators
Automatic Safety Water Gauges
Rotary Ball Bearing Ventilators

332 Michigan St.
Cleveland, Ohio

REPRESENTATIVES IN ALL LARGE CITIES 1-163

The Only Scotch High Pressure Glass

The secret of manufacturing this glass is known only to Moncrieff. His 50 years' experience in making the best only is back of each glass.

Perth Brand—Low Pressure. Unific Brand—High Pressure. *Special test offer. Write.*

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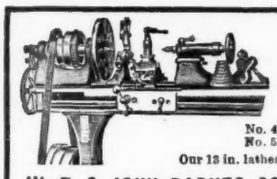

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LATHES

9 in. to 13 in. Swing.

W. F. AND J. C.

No. 4½ Lathe, 9 in. x 25 in., List $ 75.00
No. 5 Lathe, 11 in. x 34 in., List 100.00

Our 13 in. lathes made 5 to 10 feet long. Send for lathe catalog.

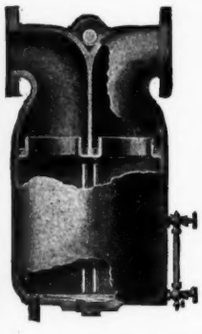
W. F. & JOHN BARNES CO., 990 Ruby Street, Rockford, Ill.

THE RELIABILITY OF STARRETT HACK SAWS

is the reason of their great popularity among knowing mechanics. They cut quicker and last longer—are dependable when most needed. There's a kind for each job from brass tubing to steel rails—get the right one. Most dealers carry them—if you don't readily find the saw you want, write us—we'll see that you are supplied.

Send for free catalog 19AG.

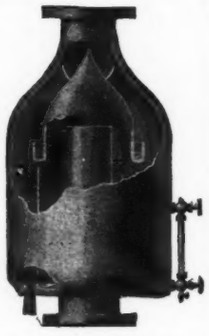
THE L. S. STARRETT COMPANY,
Athol, Mass., U. S. A.



HOPPES STEAM SEPARATORS

will deliver 99%, or better, dry steam to your engine, and owing to their large receiver capacity they protect the engine from being wrecked by sudden flushes of water. The intercepting troughs, partly filled with water, which guard the ports, are a feature found in no other Separator and entirely stop the creep of the entrainment, preventing its being carried on with the current of steam. Every Hoppes Separator is *guaranteed* to give satisfaction, and we build them in all types and sizes up to and including 66″ pipe size.

Send specifications of your requirements and we will build you a Separator to suit.



THE HOPPES MFG. CO., 19 LARCH STREET, SPRINGFIELD, OHIO

Are You Looking For Strong, Serviceable Floats?

We make 4″, 5″ and 6″ floats with a steel core on which we put our Seamless Copper Covering. There is nothing but the best of copper to come in contact with the water or steam on account of the "seamless" feature. But, naturally, they cost less than the all-copper kind. We make "Naugatuck" Seamless Copper Floats in all shapes, sizes and weights to withstand any desired pressure.

Write for book and prices.

Naugatuck M'f'g Co.

440 N. Main St., Naugatuck, Conn.

Turn On The Water As Hard As You Like

DUXBAK BELTING
TRADE MARK

or as long as you like and you will find it will have absolutely no effect upon Duxbak belting which is perfectly water proof. We will send you Duxbak Belting on approval to let you test its superior quality yourself.

Chas. A. Schieren Company
ESTABLISHED 1868

Tanners, Belt Manufacturers, **69 Cliff St., New York**

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OAK LEATHER TANNERIES, Bristol, Tenn.

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12th and Carpenter Streets, Philadelphia, Pa.

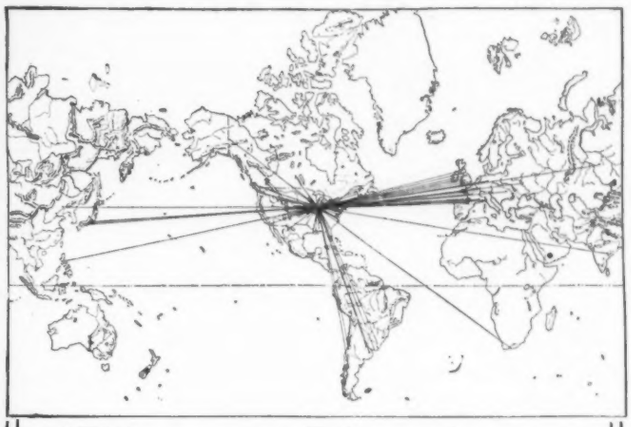
In the manufacture of
"American" Transmission Rope

only the finest selected long fibre Manila hemp is employed. It is laid up in a special lubricating compound that renders it practically impervious to water, and it is thoroughly stretched in process of manufacture. It is the most economical rope to install and maintain.

It will pay you to specify **"American"** when ordering Transmission Rope. Get our "Blue Book of Rope Transmission."

American Manufacturing Company
Largest workers of Fibre in the world
63-65 Wall Street New York City

The World Is The Jones' Field



Wherever Bituminous Coal Is Used

THE JONES STOKER

is to be found, for it is in every way the best method of burning bituminous coal.

A remarkable factor in the success of the Jones is the automatic control. The steam pressure itself automatically controls the air and fuel supply, proportioning them to each other and to varying load in the correct degree to secure best results.

This is an absolutely unique feature to be found only in Jones Under-Feed Mechanical Stokers, and in connection with the system of underfeeding and the method of introducing air between the green fuel and the fire bed, this obtains most complete combustion possible of any grade of bituminous coal.

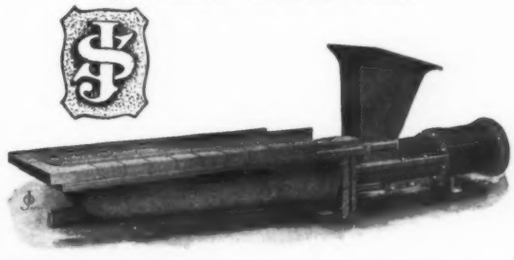
For you in your plant we guarantee that the Jones Stoker will save *at least* 10% in fuel bills over hand-firing, will enable you to run your boiler under enormous overloads, and will eliminate the smoke nuisance. It will maintain steady steam pressure at all times under the most fluctuating loads.

A big asset in placing Jones Stokers in all parts of the world has been our ability and desire to back up our goods and our claims at any cost.

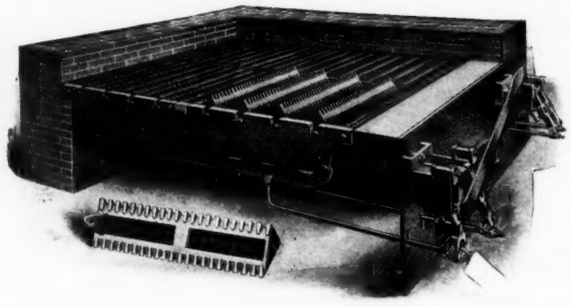
You will be interested in what Jones Stokers have done in other plants, how they do it, and what they can do in your plant. *Write.*

The Under-Feed Stoker Co. of America

General Offices: Harris Trust Building, Chicago
New York Philadelphia Boston Pittsburg Detroit Buffalo Cincinnati Toledo Minneapolis Kansas City St. Louis



Lasts the Life of Two Ordinary Grates



THE LONG DUPLEX SHAKING GRATE

Every bar in the Long Grate has *two usable sides*, one of which is in use while the other is below fire cooling off. This eliminates warping and makes the grate so durable that in actual service it will last as long as two ordinary grates.

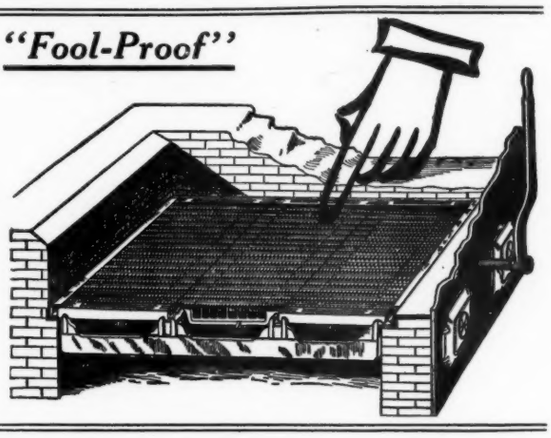
There is also a crushing and raking effect exerted when shaking that crushes the clinkers, cleans the fire thoroughly, and yet precludes the loss of good fuel through grate bars. Moreover, it is the only grate that can be shaken to extreme position without loss of good fuel.

Write for full information.

The Long Grate Bar Company
Buffalo, N. Y.

Burns Cheap Fuels Successfully—Entirely "Fool-Proof"

The Martin Grate



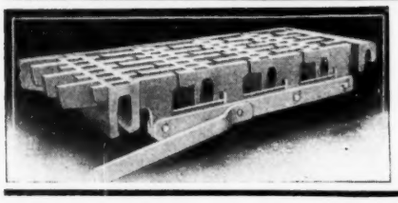
Not a dumping grate, but a rocking grate. Its action is such as to clean thoroughly the under part of the fire without loss of draft or of good fuel.

"Fool-proof" because it has no long fingers that can be left sticking up into the fire and burnt off. It returns home *automatically* under any fire.

These are a few of the points that make the Martin the best grate for your use. You will do well to investigate thoroughly.

Write for Martin Catalog.

Martin Grate Co., 341 South Dearborn St., Chicago, Illinois



The Surface Of The Grate Is Always Even

Cut shows how Armstrong grates are connected under the fire line ready for use. A long casting on one side of each grate extends down 7" from grate surface. Two flat steel bars 2" x 1/4" are fastened on each side of lugs with 1/2" steel rivets, passed through bars and lug and rivets held in place with split cotter key. When thus connected it is impossible for grates to have an uneven surface. There is also nothing to break or get out of order. Armstrong grates will reduce your coal bills and increase the efficiency of your Boiler Plant 10 to 40%. *Let us tell you why.*

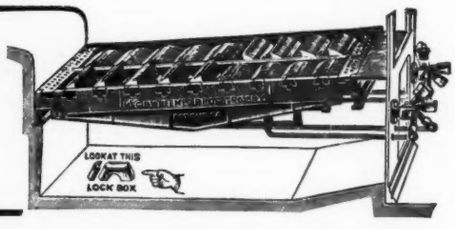
Write for Bulletins.

THE ARMSTRONG MFG. CO. : : SPRINGFIELD, OHIO

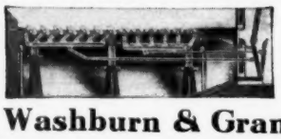
Neemes Improved Shaking & Dumping Grate

A strong, well constructed grate that is built for modern service. It burns all kinds of fuel. With it you can shake out your ashes, cut out your clinkers, or dump your fire if necessary. Write for particulars.

Neemes Bros., 41-49 Adams Street, Troy, N. Y.

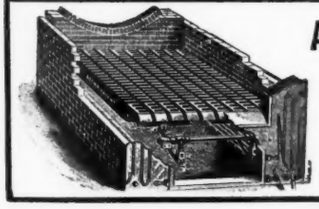


The DEAN SHAKING GRATE



is self-supporting and entirely independent of the brick work, and so can expand and contract freely. That's only *one* of many advantages. Write for booklet giving full details.

Washburn & Granger, 50 Church Street, New York.



Aetna Shaking Grate

is absolutely self-supporting. It is a practical grate, enabling you to clean the fires without opening the doors.

Write for catalog describing the whole line of Salamander Grates.

Salamander Grate Bar Co.
126 Liberty St., N. Y., Phone 4136 Cortland

AIR SPACE TO SUIT YOUR NEEDS

The Perfection Grate provides any air spaces you need. It is simple, strong and lasting. Cleans fires without loss of coal.

DETAILS?

Perfection Grate Co., WHITNEY B'LD'G. **Springfield, Mass.**

TREAD-KILL GRATES

Not money spenders but money savers
Over 11,000 installations prove it
"Ask anyone who uses them"
The grate book tells about them, too

M. H. TREADWELL COMPANY, Inc.

Chicago, 72 West Adams St. | New York, 140 Cedar St. | Baltimore, 449 Equitable Bldg

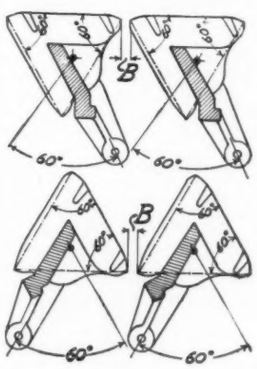
NO LOSS

With the

MACDONALD

SHAKING GRATE

Unburned fuel cannot fall into the ash pit for the space "B" is small and no larger at the end than at the beginning of the stroke. Triangular sections are removable. Points cannot become burned off, for the lever can be inserted or withdrawn only when the grates are level.



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ROBB ENGINEERING COMPANY, Ltd.

South Framingham, Mass. 38-26

PARSON

The Parson System
Parson Automatic Stoker
Automatic Coal Distributor
Ash Ejector and Conveyor

Booklets on request.

Parson Manufacturing Company
149 Broadway New York

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.

UNITS OF ANY SIZE

Aerial Transportation

One man with a Triplex Block hung from an overhead trolley can lift any load up to twenty tons and then push the load wherever the trolley goes. Write for the Book of Hoists today.

The Yale & Towne Mfg. Co.

Makers of Yale Products **9 Murray Street, New York**

HAMMEL OIL BURNERS

Over 7500

In Use Under Stationary Boilers, Locomotives, Kilns, Etc.
Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.,
609 North Main St., Los Angeles, Cal.

Built For Repeat Orders—Not For Price

The Detroit Lighting Commission bought two 400 horse power Taylor Stokers after the most agressive sales effort on the part of competing stoker companies. The Taylors cost twice as much as any other type.

It is needless to say that stokers purchased under such conditions and for such a price were watched more closely than any other stoker installation. But the decision of the Commission could not be discredited—the Taylors were worth the money.

After the installation had been carefully tested out, duplicate bids were asked for, this time for three stokers for 300 H. P. boilers. As before,

TAYLOR STOKERS

were purchased, not as an experiment or for trial, but strictly on the merits of previous performances.

Send for New Catalog to

American Ship Windlass Company

General Sales Office and Works **Philadelphia, Pa.**

Boston New York Pittsburgh Baltimore Cleveland
Detroit Milwaukee St. Paul Cincinnati

15-91

A Right Glad New Year To You

Uncle Sam Is Particular

That Is Why U. S. Automatic Injectors Are Specified For Government Plants

Government specifications are particularly exacting in order to keep out second-grade equipment. Therefore it *means something* that thousands of Government plants are equipped with U. S. Automatic Injectors.

United States Automatic Injectors give higher efficiency to the boiler because they handle hotter water and feed hotter water to the boiler than any other make. Absolute dependability is certain—all the time. If for any reason the water supply is cut off, *this* Automatic Injector will start again immediately upon return of the water.

The U. S. Automatic Injector

is simple in construction, has few parts to wear, costs no more than others—and it's a power-saver.

It has wider range—starts at lower steam and works to higher steam than other Injectors.

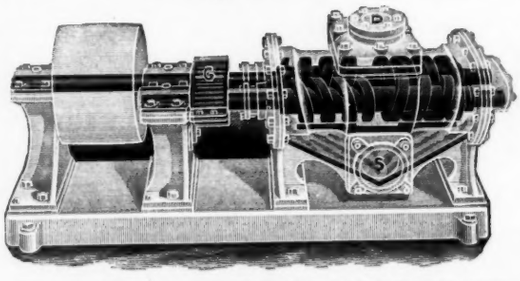
And the *automatic* feature prevents steam from being blown back into the suction pipe—which, as you may know from experience, is the cause of serious trouble when it occurs. ENGINEERS—don't fail to send for the "Engineer's Red Book." It's free—and contains information that you require every day.

Also ask for Catalog "G." You will appreciate why the Government is constantly installing U. S. Automatic Injectors.

American Injector Company

Detroit **179 Fourteenth Avenue** **Michigan**

Mr. Engineer In-Charge-Of-A-Brewery



The cut shows the extreme simplicity of the Quimby Screw Pump—the 4 screws mounted in pairs on parallel shafts; absolutely no valves, packing or small parts to get out of order.

You, of course, realize the necessity of preventing churning of the beer at any stage of the brewing process.

You may not know that the *Quimby Screw Pump* is widely used in breweries for this very reason, *i. e.*—it absolutely will not churn the beer. But it's a fact worth knowing.

Write for the Quimby Screw Pump Booklet and get full details.

William E. Quimby, Inc.

7 West 29th Street **New York City**

WHEELER CARTERET NEW JERSEY

CONDENSER & ENG'G CO.

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SURFACE, JET & BAROMETRIC CONDENSERS, AIR PUMPS & COOLING TOWERS

Steam Pumps and Condensers

Epping-Carpenter Co., Pittsburg, Pa.

If interested let us have your inquiries for

High Vacuum Pumps and Condensers

Vacuum Pumps for heating systems, Oil Pumps, Power and Electric Pumps, Pneumatic Conveyors for moving coal, ashes, etc. Blowers and Gas Exhausters in all sizes for high or low pressure.

The CONNERSVILLE BLOWER CO.

Connersville, Indiana

The Slogan of the Cameron—"Character: The Grandest Thing."

Cameron Pumps

Regular Pattern

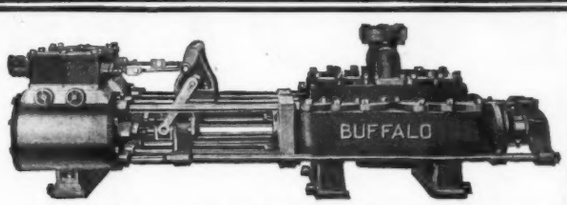
These pumps can always be counted upon for complete satisfaction. Their correct design and construction are backed by over 50 years of pump manufacturing experience.

Few moving parts, no outside valve gear, simply built with great strength—the least expensive pumps you can buy.

Catalog No. 1 sent on request to interested pump users and intending purchasers.

A. S. Cameron Steam Pump Works

Foot of East 23rd Street, New York. 12-26-11

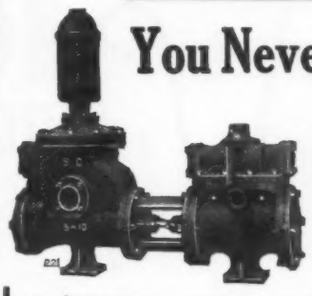


BUFFALO BOILER FEED PUMPS

Built in all types for all kinds of service. High pressures on modern boilers have compelled the production of a type which can easily handle from 150 lbs. up, and the Buffalo Duplex Outside End-Packed Plunger Pump (shown above) meets this demand as well as that of any special heavy service.

Catalog 227-A shows full line.

BUFFALO STEAM PUMP CO., BUFFALO, N. Y.



You Never Will Know

what real merit there is in McGowan Pumps without proper investigation. Send us your inquiries, when we will gladly acquaint you with our claims of curtailment in maintenance expense and the general points of

SUPERIORITY AND ADVANTAGES

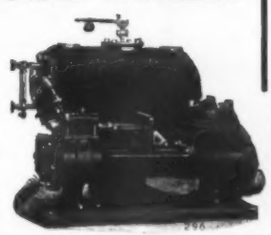
OF

McGOWAN PUMPS

which are built in piston, plunger and ram patterns, in both Single and Duplex Types for light, moderate and heavy pressures. McGowan Pumps are fully guaranteed, yet their excellence can not be proven satisfactorily to you

UNTIL YOU USE THEM

Write for Catalogues Nos. 301 and 311 now in preparation.



THE JOHN H. McGOWAN COMPANY,

CINCINNATI, - OHIO.

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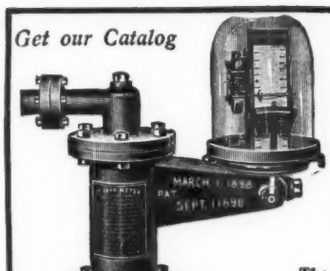

The St. John Indicating and Recording Steam Meter

Just How Much Steam Are You Using?

Do you know accurately how much horsepower is being developed to carry your loads? **The St. John Indicating & Recording Steam Meter** besides keeping a chart showing consumption by the hour, day or month, has a dial that indicates the amount at any instant. This meter is adapted not only to the measurement of steam, but also of air and all gases, water, and all fluids.

G. C. St. John

140 Cedar St., New York

Pratt Patent Rotrex Vacuum Pumps

Engine Driven

Wet vacuum type handling air and water together can be used for dry vacuum service when required.

Power requirements are low. All internal contact is dispensed with and clearances thoroughly water sealed. Under operating conditions this pump is guaranteed to maintain practically an absolute vacuum from 1 inch to 2 inches.

C. H. Wheeler Mfg. Co., North Philadelphia, Pa.

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Watson Steam Pump Governor

For maintaining an even water pressure. Should be used on all steam pumps where a fixed discharge pressure is desired. Designed right and made right, it is automatic and reliable. A trial will convince you. We also manufacture

Reducing Valves, Exhaust Heads, Separators, Steam Traps and Blow-off Valves

Send for complete catalogue.

Watson & McDaniel Company,

137 N. 7th St., Philadelphia, Pa.

Any of our goods sent on trial to responsible parties.

Deming Power Pumps

For Power Plant Service

Economical
Continuous Flow
Low Operating Cost
Write.

General Agencies

Henion & Hubbell, Chicago

Harris Pump & Supply Company, Pittsburg

Other Agencies in Principal Cities

The Deming Company, Salem, Ohio

Hand And Power Pumps For All Uses

10 TRUTHS about SKOOKUM

It is cross-section.

Used in any kind of an engine.

Made from the best of rubber.

Expands 100% in any direction.

Non-heating.

Used everywhere.

Packs the rods perfectly.

Made from the best of woven duck.

Stops all piston rod worries.

The only one-piece packing.

Whenever you go into almost any engine room in the country — wherever you see an up-to-date careful engineer — an engineer free from packing worries — there you will find Skookum, the finest Piston Rod Packing.

Send for a test sample and see it yourself.

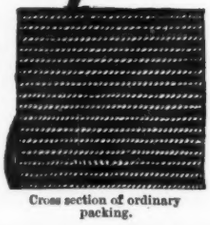
Owing to many imitations that have recently appeared on the market we have been compelled to issue this

WARNING

Beware of Infringing Imitations

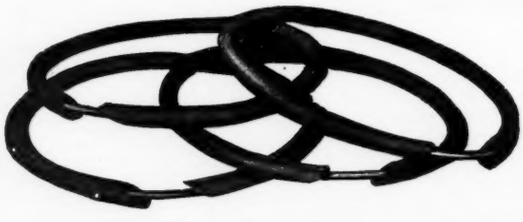
Any one-piece diagonal packing similar to our Skookum is an infringement of our patent rights, which we will protect by bringing vigorous suit against any manufacturer, seller or user.

Cross section of Skookum packing.



Cross section of ordinary packing.

Bowers Rubber Works, San Francisco, Cal., U. S. A.



Indian Red Adjustable Gaskets

For Man Holes And Hand Holes

Made of famous Indian Red stock and possess same marked virtues in resisting steam and high pressures.

Any joint may be safely and securely packed and as all short pieces can be fitted over metal core, there is no waste.

Metal core and tap included with each box of tubing.

Quickly and easily applied.

The Diamond Rubber Co.
Akron, Ohio

5 Year Guarantee Explains Success.

The five-year guarantee which goes with every Copes Boiler Feed Regulator accounts largely for its adaptation by such leading concerns as United States Government, Eastman Kodak, The Commonwealth Power Co., Boston Elevated, and numerous other concerns whose boiler equipment *total over a million horse power.*

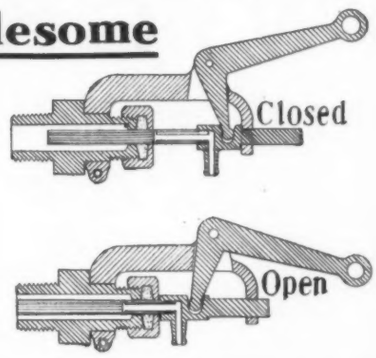
We shall be glad to send you further information on the Copes Boiler Feed Regulator and our catalog P, describing the economies of the Copes Boiler Feeding System and the construction of the "expansion-tube, check-valve" Copes Boiler Feed Regulator.

Northern Equipment Company
408-418 West Indiana St. Chicago. Ill.

"Safety" Plastic
METALLIC PACKING
For Steam, Water, Air, Gas, Etc.
SELF LUBRICATING. FRICTIONLESS.
ANY QUANTITY SENT ON APPROVAL. Send For FREE SAMPLE
Steel Mill Packing Co.,
Detroit, Mich., U. S. A.

The Original
Tripp Metallic Packing
Manufactured Solely by
TRIPP METALLIC PACKING CO. 74 India St. Boston, Mass.

The Most Efficient—The Least Troublesome
"S-C" Valveless Gage Cocks



With the "S-C" Gage Cock there is no leaking and grinding of valves, no constant attention and renewing of parts necessary. *It is valveless.*

When the lever is pulled, the stem is forced in until a hole in it comes in communication with the boiler. The water or steam enters this hole, passes through the hollow stem, and is blown through nipple. When lever is released, the stem returns to original position, withdrawing the hole from the boiler. The stuffing nut through which the stem passes is packed with metallic packing. The "S-C" Gage Cock is self-cleaning and will not clog. It is simple yet lastingly efficient in operation. Made in all standard sizes. Fully guaranteed

WRITE FOR FULL PARTICULARS.

The "S-C" Regulator Co., 303 Perry St., Fostoria, O.

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET, NEW YORK
WATER TUBE STEAM BOILERS
STEAM SUPERHEATERS—MECHANICAL STOKERS

Barberton, Ohio — WORKS — Bayonne, N. J.

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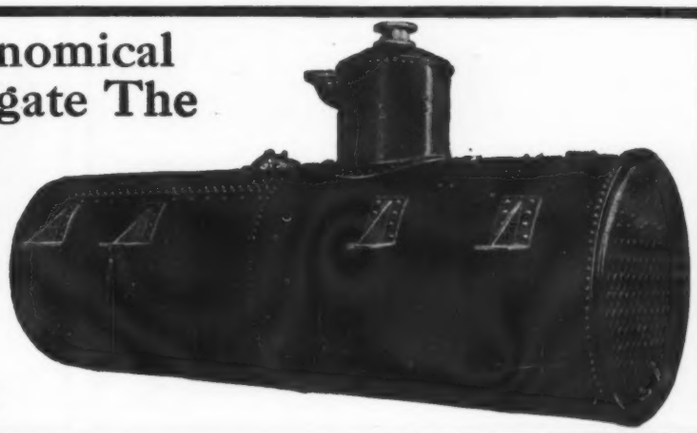
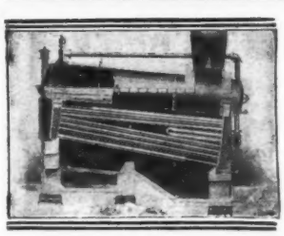
If You Are After Economical Boiler Service Investigate The SMITH BOILER



This boiler gives completely satisfactory service after years of hard work as when new. It is a quality boiler in every sense of the word. Well designed, well built, thoroughly efficient. The parts are all high grade, the kind that *wear long* rather than *wear out.* Write for catalog.

Samuel Smith & Son Co.,
Paterson Established 1844 **New Jersey**



The Casey-Hedges Co., Chattanooga, Tenn.

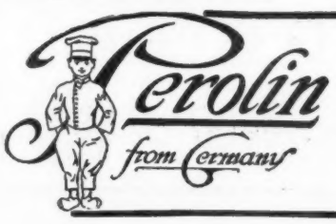
Boilers of All Types

Water Tube, Internally Fired And Return Tubular Boilers

C-H Water Tube Boiler with Superheater

Feed Water Heaters, Ice Tanks, Patent Steel Boiler Settings, Self-Supporting Stacks, Etc.

C-H Internally Fired Boiler



"THE COMPOUND THAT IS ALWAYS SUCCESSFUL"

The Germans are the recognized leaders in industrial efficiency—because they cut out all leaks,

PEROLIN GERMAN BOILER COMPOUND
(D. R. Dampf-Kessel-Mischung)

is the German Method of removing and preventing the formation of scale in boilers. Its action, being logical and positive, is entirely different from anything you have ever used. It will pay you to find out about it. Write for Bulletin and Booklet with full particulars.

THE PEROLIN COMPANY OF AMERICA, 1112-1116 West 37th St., Chicago, Ill.

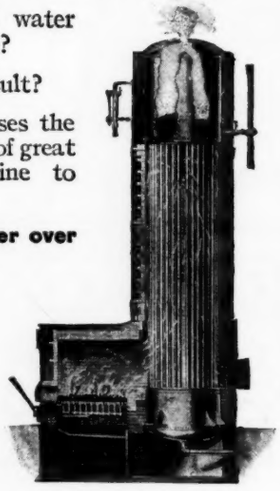
WICKES
Vertical Water Tube Boiler

Did you ever pull water from boiler with engine?

Do you know the result?

The Wickes Boiler uses the old plug-hat dome idea of great height from water line to steam outlet.

You don't pull water over from this boiler.



Ask us for bulletins —sent free.

The Wickes Boiler Co.
Main Office and Works, Saginaw, Michigan

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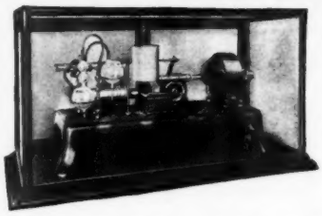
Solution For The Smoke Nuisance



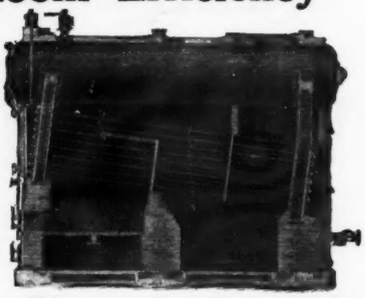
Your fireman can prevent or cause a waste of coal and annoying reports of the Smoke Inspector.

Your stacks should be watched. **The Eddy Smoke Recorder** keeps a mechanical eye on your fireman and stack. Stationed in the boiler room it shows at a glance the time, duration and density of smoke coming from your stack any hour of day or night. The only machine of its kind in the world. Read about it in our catalog. See half page ad in issue of December 5.

The Hamler-Eddy Smoke Recorder Co.
3906 So. Halsted St., Chicago, Ill.

Boiler Room Efficiency

is raised to the highest degree by **Geary Water Tube Boilers** for they are scientifically designed and built to combine safety, convenience, capacity, economy, and ability to furnish dry steam efficiently. All flange steel construction. Sizes 50 to 650 H. P.

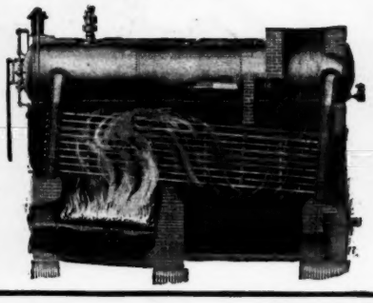


OIL CITY BOILER WORKS, OIL CITY, PENN.
Sales Offices—New York Philadelphia Chicago Pittsburg Denver Salt Lake City

Established 1864

E. KEELER CO.
WILLIAMSPORT, PA.

All Wrought Steel construction
Water Tube and Return Tubular Boilers



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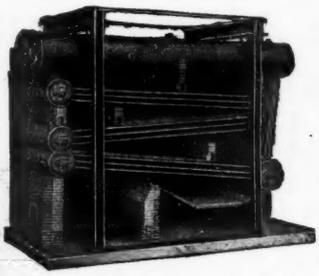


3 Times

the water has to pass back and forth through the hot gases in the Vogt Water Tube Boiler. This not only gives greater heating capacity, but also prevents scale.

The "Vogt" is made entirely of steel.

Write For Circular

Henry Vogt Machine Co., Inc., Louisville, Ky.

HEINE BOILERS
WATER TUBE

Built in units of from 70 to 700 H. P. Can be efficiently and conveniently cleaned internally and externally. Interesting descriptive literature will be sent promptly upon request.

Heine Safety Boiler Co.
2449 E. Marcus Ave.
St. Louis, Mo.

Boston, New York, Philadelphia, Pittsburg, Cincinnati, Chicago, New Orleans.

MORRIN CLIMAX BOILERS

are free from all weaknesses, make steam fast, hold the pressure under all conditions, and get *full value* out of every scrap of coal and drop of water.

Morrin Climax Boiler Co.
Pollock & Mallory Avenues, Jersey City, N. J.

UEHLING

Combined CO_2 RECORDER AND PYROMETER

is a guide to economical combustion. Write for Catalog "P100."

UEHLING INSTRUMENT CO.
PASSAIC, N. J.

The Venturi Meter For Boiler Feed

Tells at a Glance

PREVIOUS RATES
of feeding on a 12" circular chart.

TOTAL POUNDS
of water fed.

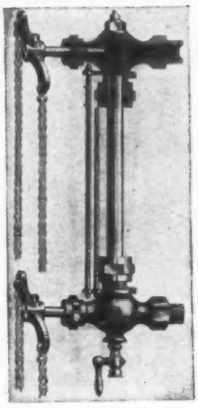
PRESENT RATE
of feeding.

Bulletin No. 68 gives complete information

Builders Iron Foundry
Providence, R. I.

W. D. HESS, 537 The Rookery, Chicago
Agent for Middle West

Ohio Water Gauge



comes to you fully packed with high grade packing, ready to use and is furnished complete with Guard Rods and Operating Chains.

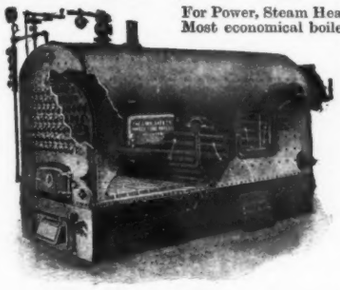
It opens or closes with a one-quarter turn of the levers and can be shut off from a safe distance, thus protecting the operator from scalding.

It can be fitted with the Ohio Ball Bearing Gland which eliminates twisting strain on glass.

Full description of Ohio Steam Specialties in Catalog K. P. Your dealer can supply you promptly. Insist on "Ohio."

The Ohio Brass Co., Mansfield, O.

Star Safety Water Tube Boilers



Star Safety Water Tube Boiler

For Power, Steam Heating and Hot Water Heating. Most economical boiler on the market today. No brick setting required. Saves space.

Harrisburg Sectional and Plate Header Type Water Tube Boilers

Riveted Steel Water Pipe, All Diameters and Gauges

Write for Catalog E **Harrisburg Mfg. & Boiler Co., Harrisburg, Pa.**

What is YOUR Evaporation?

You can increase your evaporation and decrease your fuel bills if you have a

Kennicott Water Weigher

for it gives an exact record of the weight of boiler feed water evaporated. By its use you can easily detect inferior fuel or deficient firing.

The "Kennicott" weighs water automatically without attendance—a reliable inspector—ever on duty.

Write to-day for Bulletin No. 48.

THE KENNICOTT COMPANY

Chicago Heights, Ill.

Sales Office: Corn Exchange Bank Bldg., Chicago, Ill. New York City Branch: 50 Church St.

VIGILANT FEED WATER REGULATOR

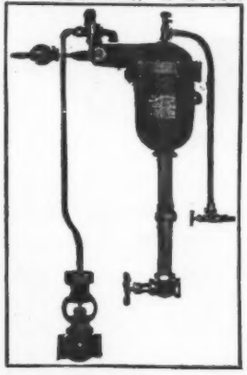
means safety and saving

It automatically keeps the feed water at a fixed level regardless of the load or firing—it is tireless, its attention is never diverted—low water and higher with the accompanying dangers are therefore positively prevented.

Absolute safety is always assured.

Besides, a saving of 6% to 15% fuel is effected by your being enabled to keep the water at the middle gauge, which allows *maximum* steam space.

Our Regulator Booklet describes the Vigilant fully—write for a copy.



These Cards Free

We are sending engineers a handy pocket size set of Engineers' Data Cards, containing many tables and figures of daily value. If you want us to send *you* a set, SEND COUPON TODAY.

The Chaplin-Fulton Mfg. Co., 58 Penn Avenue, Pittsburg, Pa.

Also Manufacturers Of The Fulton Pump Governor

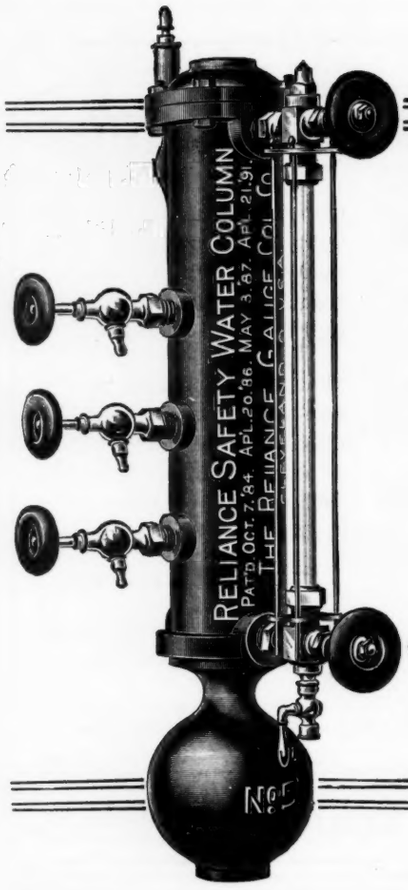
Represented by D. W. Patterson, Harrison Bldg., Philadelphia. J. E. Gimperling & Son, Dayton, O. J. S. Ward, Chicago, Ill. Burnite Machinery Co., Denver, Col.

Chaplin-Fulton Company,
58 Penn Ave., Pittsburg, Pa.

Send me set of Engineers' Data Cards and full information of Vigilant Feed Water Regulator, *free.*

Name .....

Address .....



Reliance Safety Water Column

An Aid to Efficiency
A Necessity to Safety

The Reliance Safety Water Column, by giving instant alarm when the water runs higher or lower than a selected point, protects the boiler and maintains its efficiency.

It makes burning of the boiler or explosions due to low water impossible. It also eliminates danger of too high a water level with consequent flooding of the cylinder and damage to the engine.

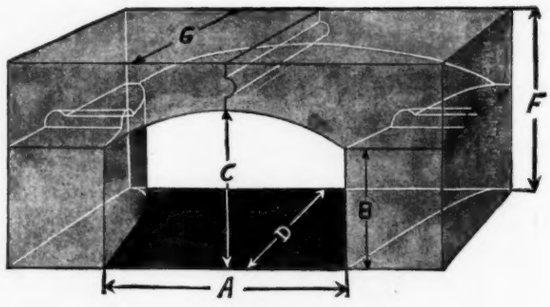
By keeping the water level at the correct point at all times, it insures dry steam and steady power, besides cutting down waste of fuel and boiler repairs.

Reliance Columns are simple yet strong in construction, inexpensive yet thoroughly efficient for the work they must do. And most important of all, they are thoroughly reliable at all times.

Reliance Products are unequivocally guaranteed to work perfectly, whether bought direct of us or through any dealer. Write for full particulars.

The Reliance Gauge Column Co.

75 E. Prospect St., Cleveland, O., U. S. A. *Cor. 18th & Market Sts. Philadelphia, Pa.*



The "STEEL MIXTURE" Arch Is Practical

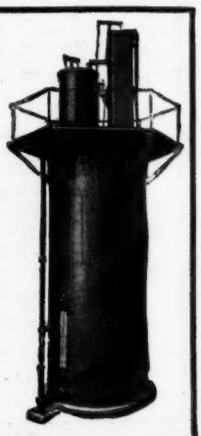
It fills a practical need and cures a weak point in the setting. This is the arch used for one opening. They come in sets for any number. The letters show the measurements needed to quote prices. If there are two or more, the distance between them is required also.

Send us the dimensions of your boiler and we will give you the cost delivered at your station.

McLeod & Henry Co., Troy, N. Y.

New York Office, 1402 Broadway.

Your Yearly Loss Would Pay For Our Water Softener



The money usually wasted in lost heat value and repair bills due to scale would pay for installing a perfect system of prevention of the cause. The Bartlett-Graver Water Softener separates the scale forming qualities from the water before it reaches the boiler and this is accomplished at the lowest cost for maintenance and labor. Interesting literature will be sent on request.

Wm. Graver Tank Works

East Chicago, Ind.

"DALLETT" PNEUMATIC BOILER SCALER

Cleans your boilers quickly and thoroughly.
Strikes over 3000 blows per minute.

Send for Bulletin No. 301.

THOS. H. DALLETT CO.

York and 23d Sts. Philadelphia, Pa.

WATER SOFTENING OR FILTRATION

FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

THE START—Mining the flint clay used in our boiler setting brick

THE PROGRESSIVE ENGINEER benefits by specifying Harbison-Walker fire brick in his boiler setting because:

Sunday work and over time on repairs are cut out of *his* calendar—his whole attention can be given to making steam.

The workmanship is best, nice clean edges, no warped and twisted brick, but the kind that lay a knife edge joint—insurance against the troubles encountered in ordinary settings.

Large stock of Standard sizes and any Specials, tongue and groove blocks or whatever else he may wish to suit his *own* ideas, we make.

There's the name Harbison-Walker—that means forty years of development in the manufacture of the highest grade fire brick made.

Our catalog will interest you—WRITE FOR IT.

Harbison-Walker Refractories Co.

PITTSBURGH :: :: PENNSYLVANIA

SALES OFFICES IN
Pittsburgh, Chicago, Philadelphia, New York, Birmingham

PLANTS IN
Pennsylvania, Indiana, Alabama, Ohio, Kentucky

THE FINISH—A corner of one of our stock sheds showing special shape work

You Get A New

Nicholson File

if you find the slightest imperfection in any one that you buy. That's our protective guarantee.

NICHOLSON Files are made of the finest steel money can buy, tempered by the famous NICHOLSON process, and manufactured by expert file makers.

NICHOLSON FILE COMPANY
Providence, R. I., U.S.A.

NICHOLSON U.S.A.

NICHOLSON Files are made in 3500 different styles and sizes.

Write for a copy of "File Filosophy."

Help Yourself *by* Helping Your Neighbor

Your neighboring buildings need heat. Individual boilers mean dirt, trouble and expense.

Sell Them Your Exhaust Steam

In this way you can make enough money to pay for *all* your fuel. Picture what this means to you—then *write for bulletin.*

AMERICAN DISTRICT STEAM CO.
General Offices and Works
North Tonawanda, N. Y.
Chicago Lockport, N. Y.

American Metal Hose For Steam

outlasts rubber hose many times.

Try a length at special trial order price and be convinced.

Price folder E on application.

American Metal Hose Company
Waterbury, Conn.

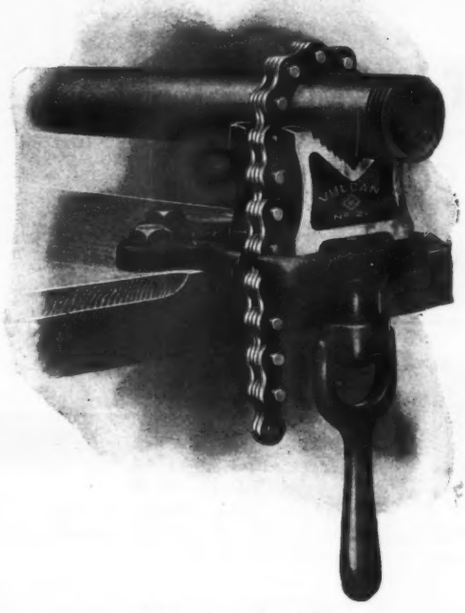
PENNSYLVANIA INTERLOCKING METAL HOSE

Pennsylvania Metal Hose is the best to use for blowing boiler flues. Its outside diameter is much smaller than rubber hose, it is easier to handle and 30% lighter. The "Four-Wall" construction is a distinctive feature. Made in all sizes from ¼ to 12 inches.

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.
1305 Arch St., Philadelphia, Pa.
New York Chicago Detroit Boston Cleveland

U. S. Flexible Metallic Tubing Company
San Francisco Los Angeles St. Louis, Mo. Houston, Tex.

Worth $10



JOS. W. MOORE
STEAM AND HOT WATER HEATING
1542 N. 18th Street, Omaha

Messrs. J. H. Williams & Co.,
Chicago, Ill.

Dear Sirs:—I picked up in a show window some five years ago one of your "Vulcan" Chain Vises, and after asking several questions as to what it was, and what it was good for—and not getting much information on the subject—I finally decided it "looked pretty good to me," so took it for a trial. After using it for about ten days—I told them (told the people I got it from) to get me another. And I wouldn't take $10 apiece for them today if I couldn't get another.

N. B.—Have bought a third one since.

"Vulcan" Chain Pipe Vise

UNBREAKABLE
UNEQUALED FOR FITTINGS
OR ANY IRREGULAR SHAPES

Capacity ⅛" to 4" Pipe.
Weight only 10 lbs.

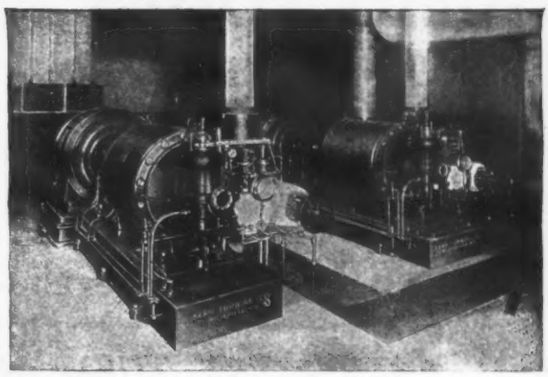
Compact—carry in bag.
Equally good Bench or Post.

Price to you $3.33 (N. Y.)

Buy from your dealer.

J. H. Williams & Co.

SUPERIOR CHAIN PIPE TOOLS
79 Richards Street, Brooklyn, N. Y.



Kerr Turbo-Generators that furnish current for lighting system, General Post Office, New York City

Kerr Turbines Meet Stringent Government Requirements

Government engineers do not make purchases foolishly. Any one who has ever sold power plant apparatus to Uncle Sam can tell you that the investigations and specifications are rigid, and that final acceptance is based upon tests that are thorough even in minute details. It is therefore significant that in every official government test, Kerr Turbines have met the guarantees as to regulation, efficiency, temperature, and steam consumption and that 35 Kerr Turbines averaging over 150 horsepower each are already at work driving pumps, alternators, ventilating fans, forced draft blowers, and generators, in such places as vessels of the navy, government lighthouses, training schools, academies, navy yards, hospitals, post office buildings, arsenals, mints, etc.

As to steam economy, Kerr Turbines are replacing ordinary reciprocating steam engines, because reciprocating engines are built for one economical load only. The variation of load makes less difference to Kerr Turbines and they never waste steam at any age, never need reboring, and need about as little attention for operating as they do for repairs. A Kerr Turbine dismantled for inspection after four years of constant service in the plant of the Brooklyn Edison Co. showed no appreciable deterioration. These facts alone are sufficient to eliminate any other choice, but Kerr Turbines are furthermore free from vibration, they require little space, waste practically no heat from radiation, their neat appearance is a source of pride, and the first cost is low. First cost usually gets first consideration; we mention it last because we know that if you study every point as thoroughly as do government engineers, you will be convinced that the **ultimate cost** of a Kerr Turbine puts this machine entirely above comparison with any reciprocating engine for driving generators, pumps and blowers.

Our bulletins describe the many types we manufacture. Every unit is built to meet the specific conditions of the plant in which it is to be installed. If interested write for full particulars and our engineers' advice on power matters.

KERR TURBINE CO.

STEAM KERR TURBINE

Wellsville, New York

Agents in all large cities

34

TRIMO TOOLS ARE IMPROVED TOOLS

There is nothing new under the sun. We are builders on the foundations of the past. All we can do is to improve what others have begun. Following out this axiom we are striving to make

TRIMO TOOLS the best Tools of their class.

TRY THEM AND BE CONVINCED

There Are None Better

Trimo Pipe Wrench

Send for Catalog No. 21

Trimo Monkey Wrench

Made By **TRIMONT MFG. CO., 55-71 Amory St., Roxbury (Boston), Mass.**

FIRST SELECT THE FUEL— Then the Producer

By all means get the producer best adapted for use with your fuel. It means a saving. It's surprising what a big saving it does really mean. How can you be sure?

It's very simple. Call upon Wisconsin Specialized Personal Service. This is a corps of experts on power plant equipment.

Included is a man who *knows* gas—knows it as you know the inside of your pocket. And he knows producers in the same thoroughgoing way. If you want a careful analysis of the fuels locally available in your vicinity and then the selection of the proper type of producer to utilize these fuels, write us.

Our object? Well, of course, we'd like to sell you, but we only ask for the opportunity to put in our bid with the rest.

We are specialists in installing the complete plant—gas producer, engine and generator.

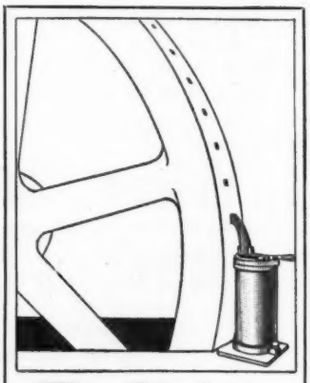
Send for further particulars.

The Wisconsin Engine Company

Corliss Engines **Gas Engines**

Gas Producers for All Kinds of Fuel

CORLISS - - - - - WISCONSIN



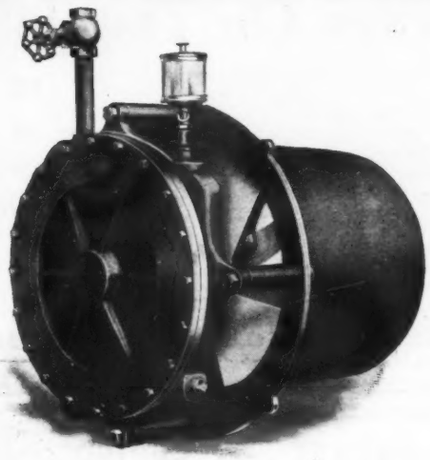
The Badger Engine Jack

It makes moving the engine off center easy.

Uses steam or compressed air.

Get one for your engine room.

WRITE FOR BULLETIN C-5.



The New Sturtevant Turbo-Undergrate Blower

A Complete Forced Draft Unit

Easily and cheaply installed in old or new plants. It will increase boiler capacity, allow the use of cheaper fuel, and tend to prevent clinkering.

The simple construction of a special propeller type fan direct driven by a turbine gives efficiency, durability, and small steam consumption and tends to quiet operation.

Built and guaranteed by the oldest and largest builders of Mechanical Draft Apparatus in the world.

Write for Bulletin 186U. It gives illustrations, description, and prices.

B. F. STURTEVANT CO., Boston, Mass.

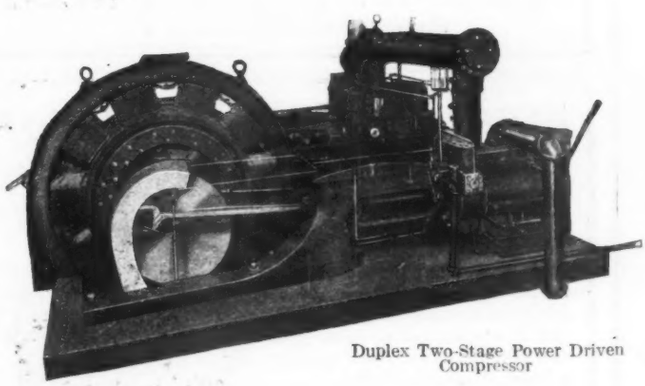
General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters, Rotary Blowers and Exhausters; Steam Engines; Electric Motors and Steam Turbines; Dust Collectors, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, etc. 819

Gearless and Noiseless Air Compressors

A feature of our Cincinnati Air Valve Gear is its ability to operate satisfactorily at high speeds making possible direct connection to electric motors of reasonable cost. This design combines highest efficiency, durability and accessibility of any type on the market. Where electricity is cheaper than steam a compressor such as here illustrated is preferable even to our Corliss type compressors.



Duplex Two-Stage Power Driven Compressor

We also build power-driven compressors for direct connection to gas engines, opening another way to securing a low cost for power per hundred cubic feet of air compressed, which is the true measure of compressor economy. Considerable useful information is given in our Bulletin L518-36 on the Improved Cincinnati Air Compressor of both steam and power driven types, which we will be glad to send you.

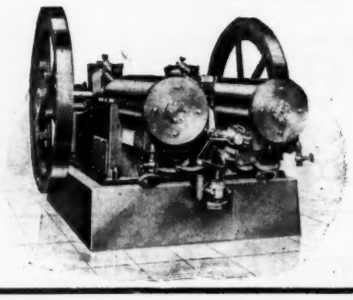
The Laidlaw-Dunn-Gordon Co

Works: Cincinnati, O.
New York Office: 115 Broadway

L 139.4

Dependability——————Always On The Job

Has Made Columbus Gas Engines Friends Everywhere



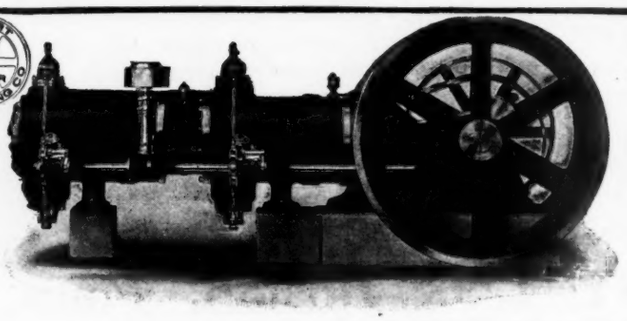
¶ They have the quality that keeps them going.
¶ 62 years' experience as builders of motive power is back of the **Columbus.**
¶ We build internal combustion engines exclusively.
¶ 8000 satisfied users.
¶ Complete types of engines for Gas, Producer Gas and Gasoline.
¶ Guaranteed to develop full working capacities. Many distinctive features.

The Columbus Is Different.

Catalog No. 2 tells why. Write today.

Columbus Machine Co., Columbus, Ohio

Established 1849



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Develops a steady and reliable power under continuous and severe service on

Economical Fuel Consumption

Perfect ignition and positive vertical valves, complete in design and details of construction.

ALL WORKING PARTS READILY ACCESSIBLE.

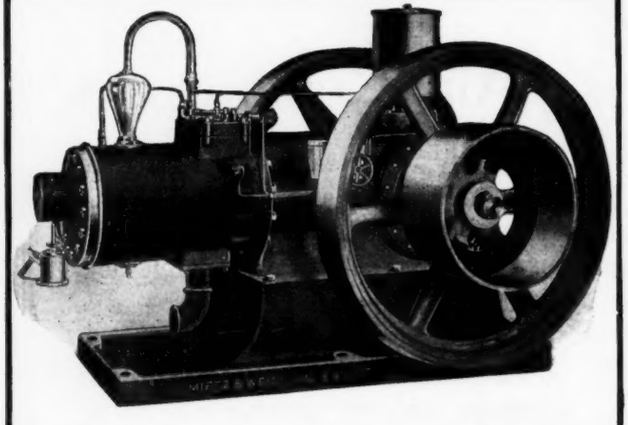
Highest Possible Efficiency And Perfect Regulation

are characteristic features of Bogart Engines. Made in stationary and portable types, single cylinder and tandem, sizes, 3½ to 600 H. P. Bulletin 20 on request.

BOGART GAS POWER ENGINEERING COMPANY

Complete Gas Power Installations

General Offices, Buffalo, N. Y.



The Mietz & Weiss Oil Engine Reduces Power Cost

They operate on kerosene, fuel oil, distillate and crude oil. All electric ignition devices, carburettors, vaporizers, cams, gears, valves, etc., are eliminated from these engines. Simple, safe, reliable, durable and very economical. 150,000 horse power in daily operation. Suitable for any service.

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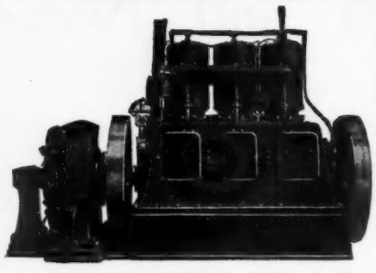
TURNER FRICKE GAS ENGINE



A high grade, close regulating engine.

Operating on natural, illuminating or producer gas.

Absolutely guaranteed in regard to operation, workmanship and material.

Write for Catalogue.

Agents wanted everywhere.

TURNER FRICKE MFG. COMPANY

Main Office, Pittsburg, Pa.

Bruce-Macbeth Gas Engines

Noted for their

Simplicity, Reliability and Economy

A recent acceptance test on two of our 200 H. P. Four Cylinder Engines showed a gas consumption of less than 9 cu. ft. per brake horse-power hour, while our regular guarantee is 10 cu. ft.

You always receive more than you pay for when you purchase a Bruce-Macbeth Engine.

Correspondence invited

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Gas Engines 350 to 3000 H. P.

Steam Engines 50 to 10,000 H. P.

The New Cooper Gas Engine
Built by
THE C. & G. COOPER CO.,
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OTTO

GAS AND GASOLINE ENGINES

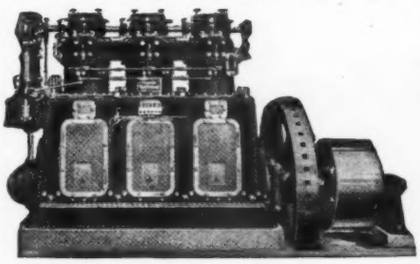
Will give you Dependable and Economical Power

The First Cost Will Suit You
The Final Cost Will Please You

From 1 to 120 H. P. Send for Bulletin No. 9, just off the press.

THE OTTO GAS ENGINE WORKS
3406 Walnut St. Philadelphia, Pa.

"Warren" Gas Engines
The Ideal Guaranteed Power for Electric Lighting Plants



One Brake Horse Power Hour on 10,000 B. T. U., which means 12 cu. ft. of Natural Gas, or One and One-Quarter Pounds of Fuel Gasified in Our Suction Gas Producer. It is so much cheaper than any other, in both operating and fuel costs, that it pays back a handsome interest on the money invested in the installation. Regulation sufficiently close to meet the most severe requirements of Electrical Service.

Manufactured by

Struthers-Wells Company, Warren, Pa.
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RICE & SARGENT
CORLISS ENGINES
Reliable and Economical
Designed and Built by
PROVIDENCE ENGINEERING WORKS,
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U.S. METAL POLISH
INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:

THE ONLY METAL POLISH
that works quick and easy and keeps its lustre. Holds old trade and makes new. IT DOES NOT DETERIORATE. Established 16 years.
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Sold by Agents and Dealers all over the world. Ask or write for Free samples. Highest Award, Chicago, '93; St. Louis, '04.
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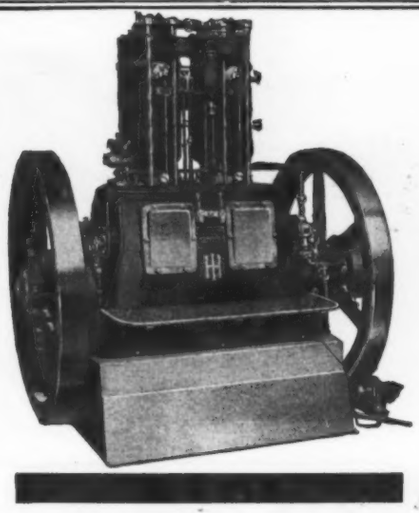

The Right Power For You

The I H C 25, 35, or 50-horse power, two-cylinder gas engine is as closely governed as any steam engine, more economical, takes up only half as much space, and is just as steady and dependable.

These advantages deserve your consideration. They have been the means of selling I H C engines to thousands of other shop, mill and factory owners who bought the I H C after closest investigation and comparison. Let us refer you to some of them—perhaps you can see one of these engines at work in your own city. The style shown in the illustration is only one of a complete line. There is

An IHC Gasoline Engine

to fit your power needs for continuous or intermittent work, for operating machinery of all kinds and for generating lighting power. The two-cylinder vertical 25 and 35-horse power I H C engines have absolutely interchangeable parts—no "rights and lefts." Any part of one cylinder may be used on the other and the cylinders may be changed from one side to another.

The enclosed crank case, perfect lubrication, and the efficient fuel mixing, controlled by a fly-ball type of governor, are other I H C advantages that have placed I H C engines in the spotlight of public approval.

The I H C line includes engines of many styles and sizes, from 1 to 50-H. P. to meet every need. They are built to operate on gas, gasoline, kerosene, distillate, or alcohol. All are backed by the I H C reputation for highest quality, longest and best service. Write at once for the I H C engine catalogue.

International Harvester Company of America (Incorporated)
67 Harvester Building Chicago, U. S. A.

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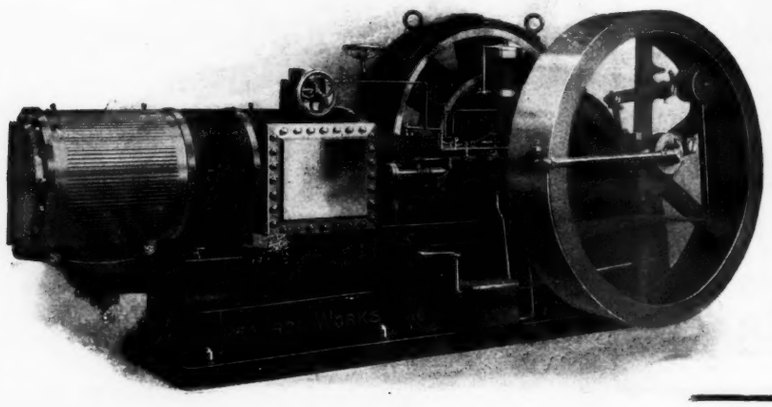

Ames Engines

The acknowledged Standard—In Isolated Lighting and Power Service

Center and Side Crank Type

Ames Iron Works

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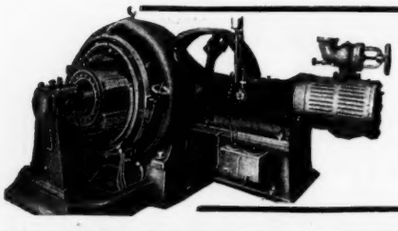


SKINNER ENGINES

are best for lighting and power purposes on account of their close regulation and maintained economy.

SKINNER ENGINE COMPANY, ERIE, PENNA.

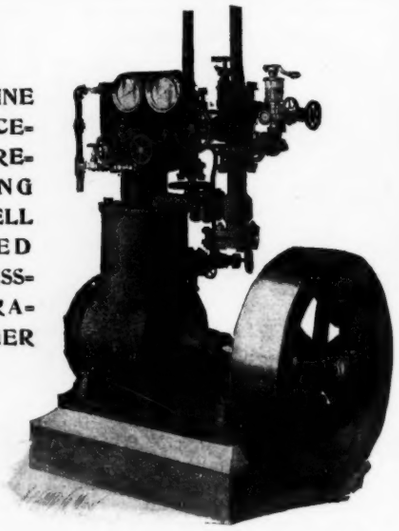
Branches in 21 Cities

ENGINES REPAIRED EVERYWHERE

Experts with portable tools sent on a moment's notice to make all kinds of repairs to Engines, Ice Machines and Pumps in position. Our first class work is the result of over forty years' experience.

H. B. UNDERWOOD & CO., 1021 Hamilton St., Phila., Pa.

A SMALL MACHINE FOR SMALL ICE-MAKING AND REFRIGERATING PLANTS. AS WELL CONSTRUCTED AND AS SUCCESSFUL IN OPERATION AS LARGER OUTFITS.



VERTICAL SINGLE ACTING AMMONIA COMPRESSORS

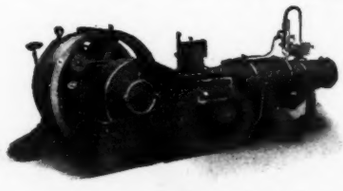
Built with fewest possible number of parts. Sold at low price. Excels all others of like size in every point—simplicity, efficiency, reliability, smoothness of action, etc.

We build all kinds of Ice-Making and Refrigerating Machinery, a full line of Corliss Engines, and also design and equip complete power plants. *Write for catalogs.*

The Vilter Manufacturing Company

845-894 Clinton Street, Milwaukee, Wis.

Ball Engines



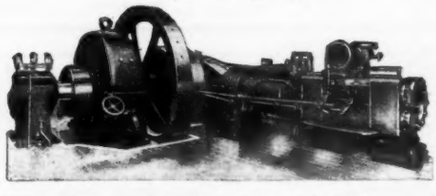
are adapted for the most exacting requirements of driving electric generators. Built in the single cylinder tandem compound and cross compound single valve automatic; and single cylinder and cross compound high speed Corliss types.

Ball Engine Company Erie, Pa.

We Have The Enviable Reputation

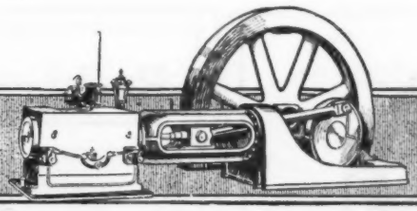
of furnishing only the best work and materials in our engines. Fitchburgs claim superiority and they make good.

Send for our catalog.

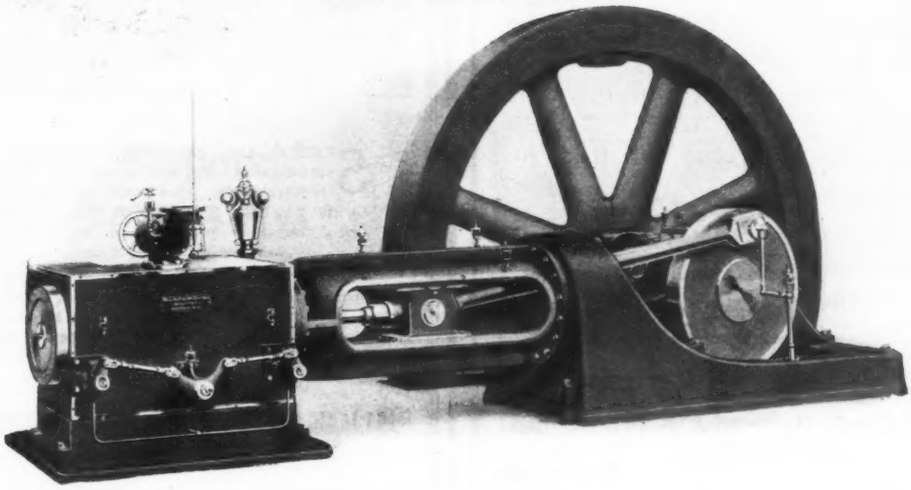


Fitchburg Steam Engine Co., Fitchburg, Mass.

Merton G. White, Room 9015, 1 Madison Ave., New York. H. J. Gebhardt, 1419 Fisher Bldg., Chicago. Geo. H. Connor, 49 N. 7th St., Philadelphia, Pa. W. C. Teas, Chattanooga, Tenn.



The ROLLINS ENGINE



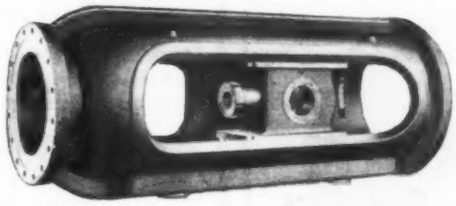
The Thing To Buy Is Engine Performance

Of course you buy an engine because of *what it will do*—and yet in most cases you don't at all.

But that's the only logical way to buy an engine of all things, because when you buy one you expect it to give you good work for twenty, thirty or even forty years.

Realizing this, we sell Rollins Engines on the "service before and after sale" idea, which means that a Rollins engine is bound to be a *profitable*, permanent investment.

In other words, our selling method means that the buyer actually buys *proved* and *guaranteed performance.*



Don't you want to buy this way?

Here's another of the series on Rollins parts—

The Rollins Heavy Duty Crosshead Guides

The trunk casting containing crosshead slides is unusually heavy, and in entire harmony with the heavy duty design.

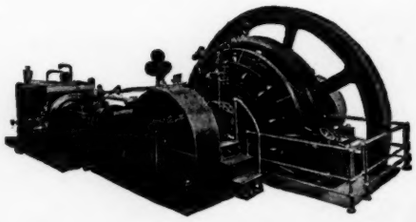
Crosshead slides are very wide and bored in special machine that faces both ends, at same time insuring perfect mechanical accuracy. Bottom slide is water-jacketed, a feature of demonstrated merit as it prevents all distortion caused by bottom slide expanding more than the top. Keeps the slides straight and in perfect line.

Oil pockets at ends of slides provide for surplus oil. Everything about a Rollins Engine is founded on quality and nothing is dominated by cost in the least detail.

Send For A Copy Of The Rollins Engine Catalog

Rollins Engine Company, Nashua, New Hampshire

ROLLINS



Have You An "Allis" Engine?

Perfection in any line is almost impossible of attainment but "Allis" Engines represent the highest development of the engine builders art.

Their reputation has been earned by the satisfaction they have given.

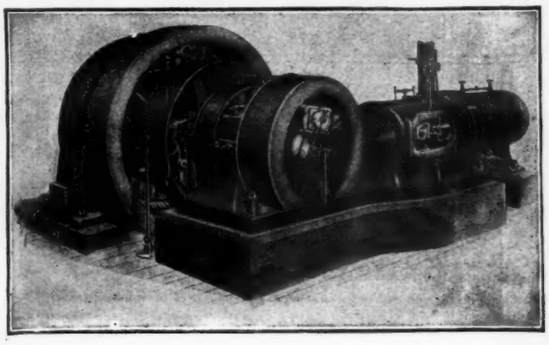
If you are in need of such equipment let our representative show you these engines in your neighborhood.

Allis-Chalmers Company

Builder of Complete Power and Electrical Equipment

Milwaukee **Wisconsin**

Buckeye Steam Engines

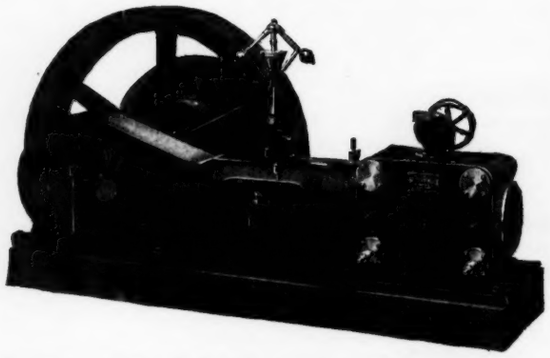


SIMPLE and compound, condensing or non-condensing, are built to meet each customer's requirements. How well they succeed is shown by the fact that thousands in every class of service are giving daily testimony to the close regulation, economy and reliability obtained.

Sixty-three years of practical engine building have resulted in perfection of each detail of design and construction. Buckeye Steam Engines are the simplest high class engines on the market. Send for catalog O.

BUCKEYE ENGINE COMPANY
Salem, Ohio

The Watts-Campbell Corliss



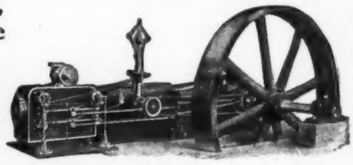
A Proof Of Engine Efficiency

For 45 years the **Watts-Campbell** Corliss Engine has been giving entire satisfaction. We have never had even a murmur of dissatisfaction from a purchaser; they are all enthusiastic in its praise. *Write for particulars and learn the reason.* We also make Ice and Refrigerating Machinery.

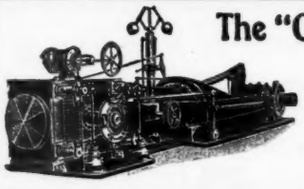
Watts-Campbell Company,
Newark, N. J., U. S. A.

The Harris-Corliss Engine

There are many features which have popularized the Harris-Corliss Engine among engine users in all parts of the world, chief of which is the Brown Patent Releasing Gear. This gear is found only on the Harris-Corliss. Let us know your engine needs and we'll submit prices.



Wm. A. Harris Steam Engine Company
Providence, R. I.
Southern Office, 1000 Realty Bldg., Charlotte, N. C.



The "Ohio" Corliss Engine

Manufactured by
The Griffith & Wedge Co.
Established 1840.
Zanesville, Ohio.
New York Office, 2 Rector St.
Send for Catalog.

Fleming
Harrisburg
Engines

Single and Corliss Valve **Simple and Compound**

Manufactured by
Harrisburg Foundry & Machine Works.
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McIntosh, Seymour & Co.

Auburn, N. Y.

ENGINES

Vertical Horizontal Belted Direct Coupled

Simple Compound
Triple Expansion

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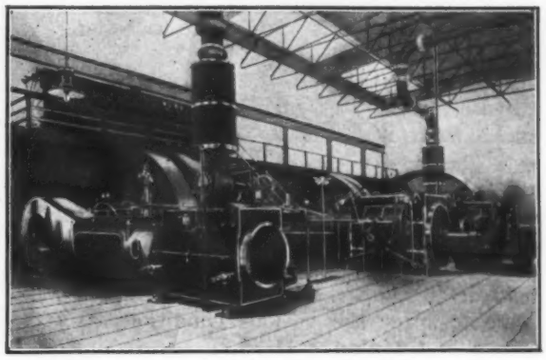
The cut below shows a good example of motive power in a modern paper mill. Let us show you some of our many installations, both variable and constant speed types.



Send for bulletin "Y."

The Hooven, Owens, Rentschler Co.
Hamilton, Ohio

Twin City **Corliss Engines**

They are built for every kind of service.
Let us tell you about them.

Nuenzel Gas Engines and Producers

The shortest cut from fuel to power known. Made in all sizes up to 300 horse power single acting and up to 900 H. P. double acting.

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STEAM means coal; coal costs money; if you would save both and secure the maximum of power at a minimum cost, purchase and install one of our latest High Speed Corliss Engines equipped with the "Franklin (patent) Horizontal Gravity Latch—releasing valve gear. Highest attainable economy and close regulation guaranteed. Rotative speed 150 to 200 revolutions per minute. Direct connected or belt types, either simple or compound.

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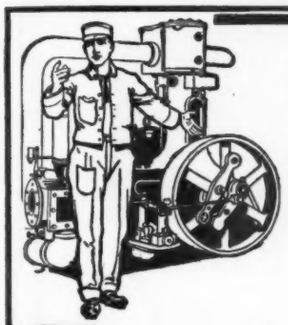

WRITE for a copy of our booklet entitled "The Modern High Speed Automatic Engine," which describes

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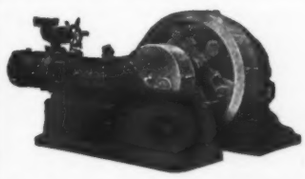

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Ridgway Side Crank Engines

are lubricated by the well known automatic system of splash oiling. Bearings, pins and guides receive positive and copious lubrication with every revolution of the engine. This means long life to wearing parts.

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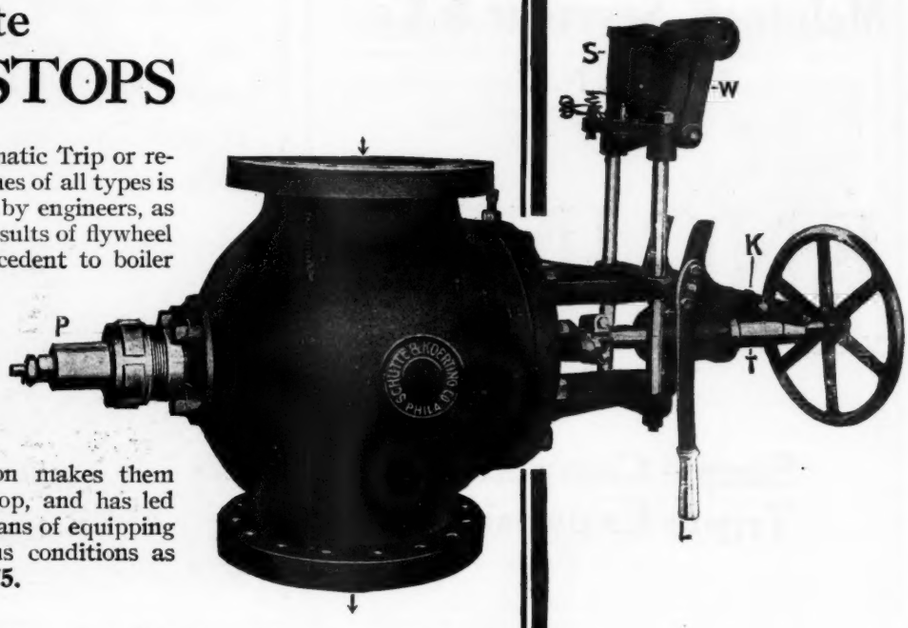
Schutte
ENGINE STOPS

The necessity of an Automatic Trip or reliable Engine Stop on engines of all types is now universally conceded by engineers, as the frequent and direful results of flywheel explosions has taken precedent to boiler explosion, while the safeguards and attention devoted to the latter far exceed those of the former. The construction of our balanced valves and their adaptability to quick and positive action makes them superior as an Engine Stop, and has led us to devise the several means of equipping same to meet the various conditions as shown in **Catalog 8-D-75.**



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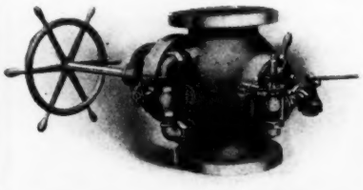
40 Engines In One Plant To Be Equipped With The Locke Automatic Engine Stop

This order was placed after having tested the Locke Stop in competition with other makes. The order came from the National Tube Co., and shows how the Locke Engine Stop is looked upon by large users.



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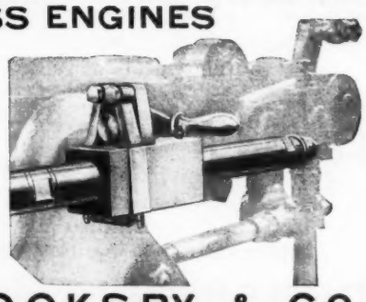

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"Gears must drive machinery without vibration. Many high speed metal gears do this when new, but after slight wear they begin to ring or rattle. The wear becomes more uneven and vibration follows. Vibration is disastrous to both machine and machine work. A machine on which nuts have worked loose, or on which the nice fits and accurate alignments have been destroyed by vibration will not do such accurate work. In the case of machine tools with cutting edges, vibration invariably makes the cut irregular and dulls the sharp edge more quickly. You can figure as a safe rule that the destructive effect of gear vibration increases in about the same ratio as the noise."

That is about the way a college professor would talk to you about noisy gears. An experienced shop manager would add that outside of the delays and expense for renewing gears that have stripped because of vibration, the noise of high speed metal to metal gears is expensive also in misunderstandings and in creating bad feeling among the workmen.

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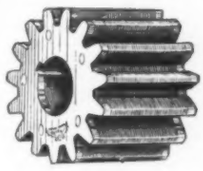

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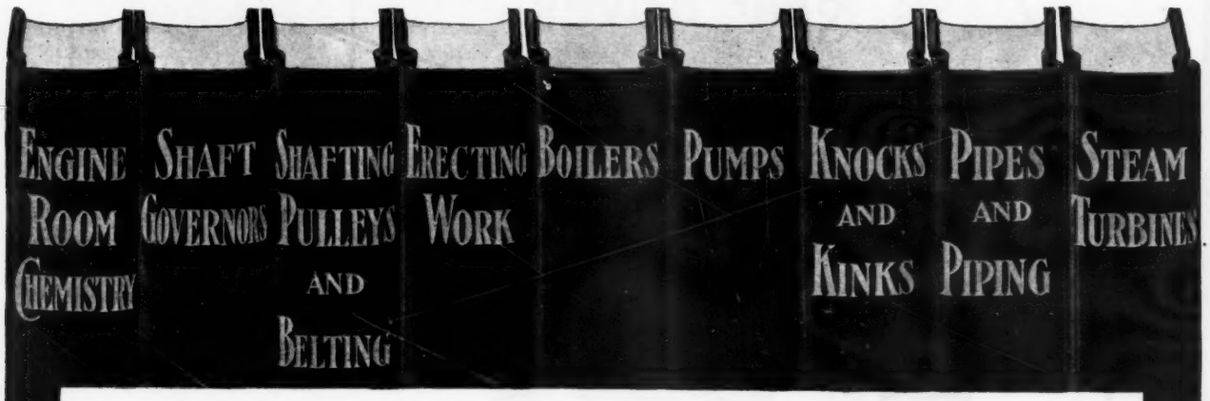

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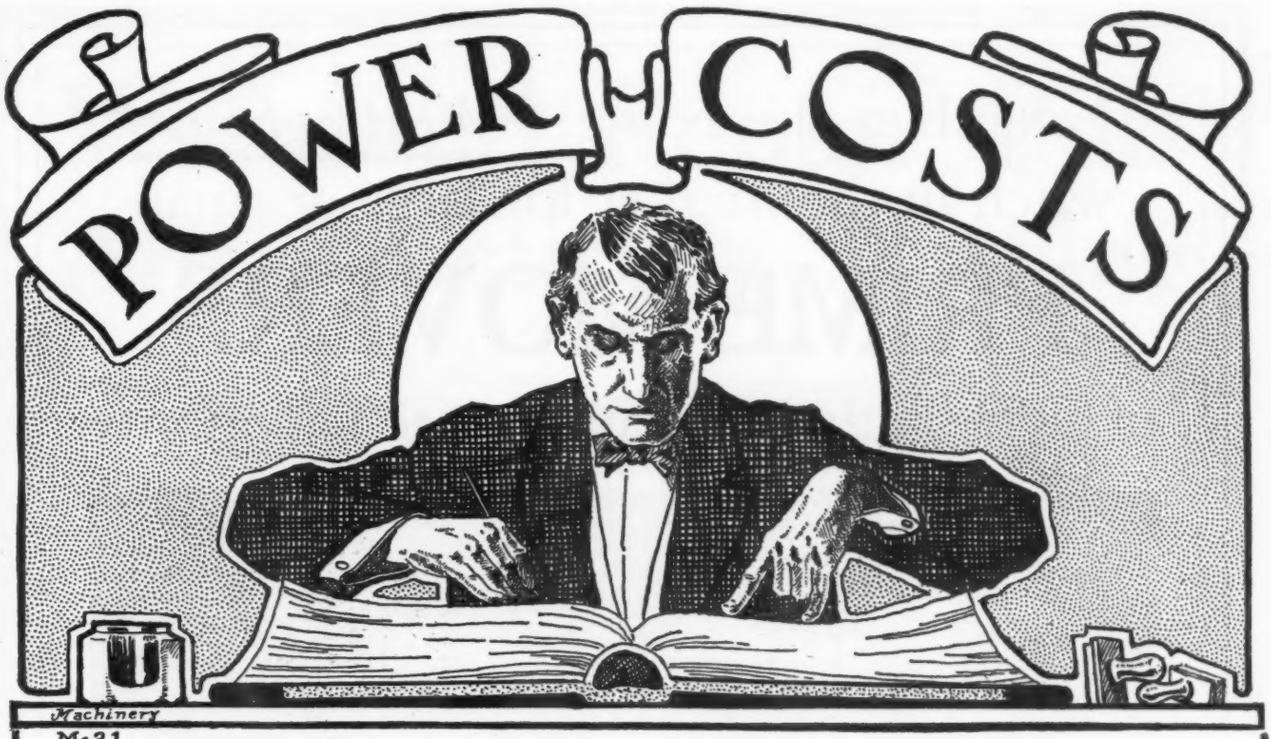

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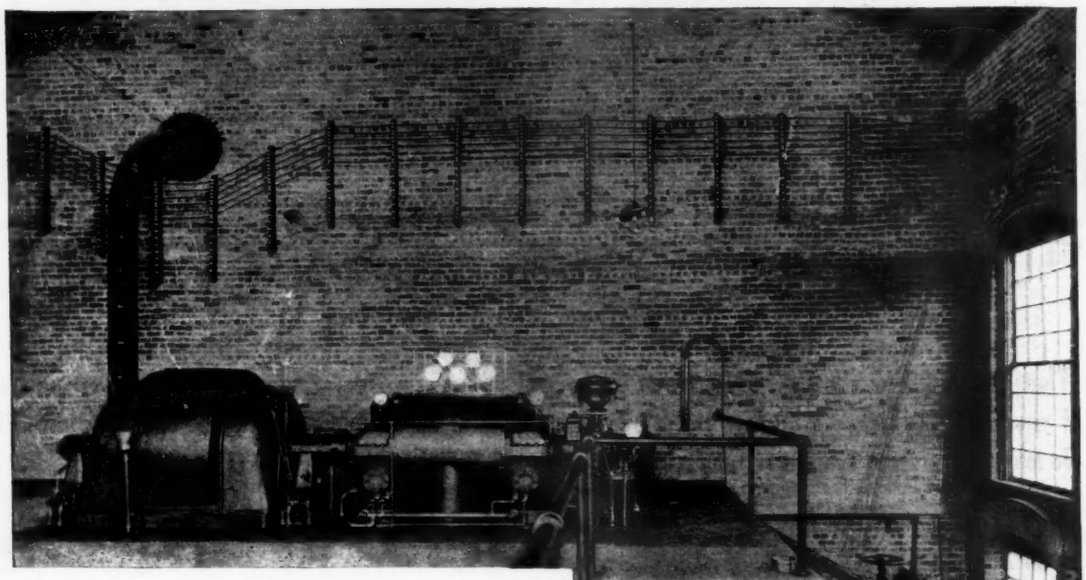

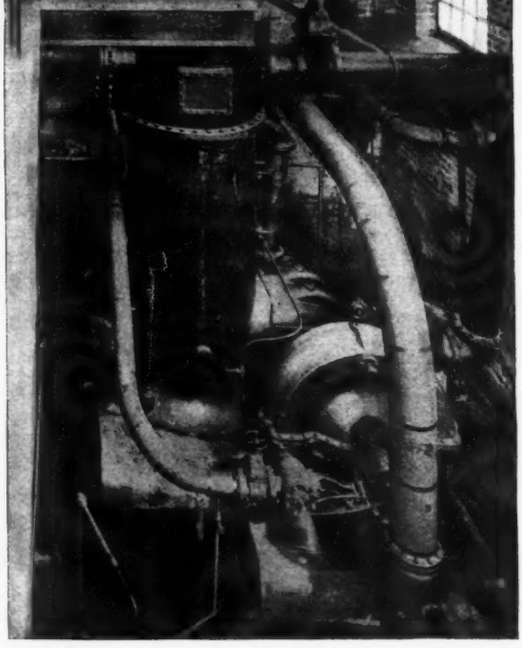

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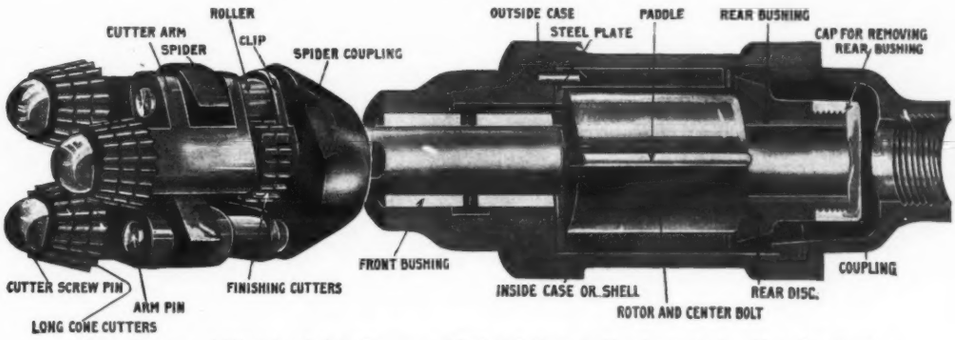
Weinland Repair Bills Are Practically Nothing



Cross Section of Weinland Air Cleaner with Quick Repair Head attached. Note few parts.

ONE of the large Electric Stations in Detroit has cleaned its ten boilers six different times or equivalent to cleaning sixty boilers, since May, 1910, with one of our Air Driven Cleaners and it has cost them nothing for repairs except for new cutters and even this has been a small expense.

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¶ Do you know that it takes less time to clean boilers with **Weinland Cleaners** than with any other type? Don't take our word for this statement, prove it yourself. Let us send you a Weinland Cleaner on trial and if it doesn't turn out to be the best one you have ever used you can ship it back to us. Anyhow, write for Catalog L, fully describing over seventy different cleaners which you could use.

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Makers of Weinland Boiler Tube Cleaners, Automatic Cut-off Valves, Reseating Machinery, Boiler Tube Cutters and Water Strainers. 166

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